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ERIKSON'S TECHNIQUE WITH THE UNIVERSAL APPLIANCE

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INTRODUCTION

**I**NCENTIVE.—In attempting to evaluate malocclusions it soon became apparent that, at least to some degree, an abnormally forward position of posterior teeth was a constant finding in nearly all cases of crowded dental arches. If the posterior teeth were excessively mesially displaced, and if from a study of the profile there appeared a tendency toward protrusion, the extraction of four dental units did not seem to be too much of a sacrifice for a correction of the condition. In fact, treatment without extractions, but with acceptance of the posterior teeth positions, was certainly a hazardous procedure if stability and facial profile were to be relevant issues.

Many of the cases observed were not of an extreme nature, but rather presented varying degrees of dental crowding with little or no profile disturbance. Conventional methods of treatment without extractions seemed to offer too little space for proper arrangement of the teeth. The main difficulty was the inadequate result of treatment in the lower arch, while the upper arch was usually treated satisfactorily. The extractionist approach obviously offered too much space in both dental arches, causing a needless sacrifice of teeth in the patient who could be treated by another means.

For the infrequent case, the extreme condition, extraction was a satisfactory solution which could be offered the student; for the seemingly most frequently occurring case, the mild condition, much was left to be desired in the way of treatment.

While a student at the University of Kansas City, I was permitted to initiate for one patient treatment based on an article by Erikson.<sup>1</sup> Although the academic term was insufficient to see any extensive results, there was enough clinical evidence obtained to realize that Erikson's contention had a basis. This

This thesis was presented as partial fulfillment of the requirements for the degree of Master of Science, University of Kansas City, School of Dentistry; the portion concerning treatment of the nonextraction case was presented, under the title of "A System of Treatment With the Universal Appliance," before the American Association of Orthodontists, Louisville, Ky., April, 1951.

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belief, added to a realization that the full account of simultaneous distal movement of buccal segments had not been given, inspired me to seek further information. Opportunity came when Erikson\* consented to serve the Army as a civilian consultant at my present station. It has been through this student-consultant relationship that further study has progressed, and that this thesis has been made possible.

Erikson's technique, as presented in this thesis, was formulated solely by him, and had been tested clinically by him over a twelve-year period prior to the association just mentioned. I, then, have in no way contributed to the technique; nor have I, by implication in writing this thesis, organized the details of the technique presented.

*Purpose.*—It is not the purpose of this thesis to offer proof of distal movement in patients treated with Erikson's technique; nor is the purpose to propose a philosophy of the Universal appliance which has been done by Atkinson.<sup>2</sup> Its objective is to record in detail the technical procedures involved with such accuracy that others may apply the plan of treatment, if they so desire.

#### REVIEW OF THE LITERATURE

*The Theory of Forward Translation of Teeth.*—As related by Talbot,<sup>3</sup> many clinicians agreed that malpositions of teeth were expressions of faulty growth of the jawbones. Divergency of opinion arose not from the perception of the basic cause but in the explanation of how the cause operated to produce the various effects that were observed in the dental arch.

Both Brash<sup>4</sup> and (according to Lundstrom<sup>5</sup>) Franke maintained that dental irregularities were the result of failure of the first permanent molars to move laterally during growth of the jaws. According to their opinions, the first permanent molars never moved forward in the alveolar bone during the transitional growth process of deciduous to permanent dentition. Angle<sup>6</sup> propounded his classification of malocclusions on this same belief in permanency of the first molar positions anteroposteriorly. Except for those few who had some misgivings as to the soundness of Angle's dictum, Zielinsky, also according to Lundstrom,<sup>5</sup> expressed the prevailing thought of the time that it did not behoove him to doubt the statements of so experienced a practitioner as Angle. Thus, orthodontics for many years was dominated by the plan of moving the buccal segments of the arches laterally to permit alignment of the remaining teeth.

In England, Wallace<sup>7</sup> contended that the first permanent molars did move forward as well as laterally in the alveolar process. In explanation of growth processes of the jaws and teeth, he used Hunter's description and supplemented it with Zsigmondy's illustrations of anatomical specimens. With this concept of normal growth changes, it followed that application would be made to cases wherein abnormal growth symptoms existed. According to Wallace, in cases showing a premature loss of deciduous molars, a mutilation, or a tooth extruded from the general line of the dental arch, there would also be a midline shift to the mutilated side. This he interpreted as evidence that all the teeth of the

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symmetrical side had moved toward the mutilation. That the teeth of the asymmetrical side, posterior to the mutilation, had moved forward was even more obvious. Wallace concluded that all, or nearly all, cases of crowding in dental arches were the result of excessive forward translation of the posterior teeth; and, that this excessive movement was due to defective anteroposterior growth of the jaws.

Grieve<sup>8</sup> for over twenty years used as the main theme in many of his papers Wallace's theory of forward translation of teeth. It was believed by Grieve that forward translation of teeth would someday become established as a scientific principle to guide us in the analysis and treatment of malocclusion.

Downs,<sup>9</sup> using a Grünberg symmetroskop, made a very detailed study of abnormal mesial drift resulting in malocclusions. Again it was pointed out that contact point disturbance liberates two opposite major forces: first, the distal pressure of the musculature; second, the anterior component of force that tends to force teeth mesially. He also classified cases according to the relationship of the drifted teeth to their alveolar process, to maxillary and mandibular bases, and to the cranium. Milliette<sup>10</sup> listed various factors that contribute to disturbances in arch continuity, and described how forward translation of teeth was the result.

Dewel,<sup>11</sup> as recently as February, 1949, published a very thorough clinical appraisal of malocclusions. As a means of determining forward displacement of posterior teeth, he added these indicative signs: mesiolingual rotation of upper first molars, premature eruption of upper second molars, and insufficient space for canine eruption. In addition, he offered this question and answer: "What effect does mesial drift and early eruption of the upper second permanent molars have in retarding growth of the deeper supporting structures of the area? It is reasonable to suspect that full development of posterior alveolar structures is not achieved in the absence of the stimulating influence of normally positioned teeth, both erupted and unerupted."

*Treatment Procedures to Correct Forward Translation.*—If the concepts that were held by Franke, Brash, and Angle had been correct, treatment of the abnormally developed dental arches would have been resolved into widening the arch by lateral movement of the buccal segments, and then aligning the irregular teeth. Time has shown this principle to be fallacious.

Grieve,<sup>12</sup> since he was so convinced that forward translation of teeth was basically sound as an explanation for crowding of teeth, was one of the first to attempt correction by distal movement of the buccal segments. He recognized, in the beginning, that anchorage was the most difficult problem in treating patients by this method. Using Orton and Lischer's<sup>13</sup> established norm for overbite, Grieve<sup>14</sup> further related forward translation with excessive overbite, and maintained that failure to correct excessive overbite would result in failure to maintain the results of treatment.

While recognizing the need in both arches for distal movement of the posterior teeth, most attempts to move teeth distally have been limited to the upper arch. Without doubt this can be explained in part by anchorage difficulties

encountered in the mandible. Sved<sup>15</sup> described a maxillary splint and headgear that he used for distal movement of the entire maxillary arch. Closson<sup>16</sup> used a headgear fastened to an arch wire and molar bands to move the maxillary teeth distally; while Johnson<sup>17</sup> illustrated cases in which distal movement of the maxillary posterior teeth had been accomplished with his twin-wire appliance.

Fisher<sup>18</sup> presented clinical evidence to show that with few exceptions neither mandibular anchorage nor "prepared mandibular anchorage," without extractions, could sufficiently resist the pull of intermaxillary force to effect a posterior movement of the maxillary dental arch without a forward movement of the mandibular teeth. Higley<sup>19</sup> stated this same thought in discussing cephalometrics and anchorage.

Downs<sup>20</sup> did describe a technique for distal movement of mandibular teeth, and after cephalometric studies concluded that there was satisfactory clinical evidence that buccal teeth could be moved distally, and that there was conclusive cephalometric evidence that this could be done.

Erikson<sup>1, 21</sup> adapted the essential principles of Downs to the Universal appliance; and, whereas Downs apparently limited his attempts to the mandibular arch, Erikson treated both arches simultaneously for distal movement of the buccal segments.

#### CONCEPT OF ERIKSON'S TECHNIQUE

*Basic Considerations.*—Although it is not the purpose of this thesis to delve into the intricacies of case analysis or to offer a scheme for diagnosis, a general consideration must be given the problem.

It is conceived that dental arches can be grouped into three large categories: (1) those with just enough room in the arch to accommodate the teeth; (2) those with too much room in the arch; (3) those with too little room for the teeth in the arch. Further complication may arise in respect to the relation of the denture to the cranium.

If there is just enough room to accommodate the teeth, the malocclusion may be manifest as a malrelation of one arch to the other without intramaxillary malpositions of the teeth, dentocranial relationship being normal or abnormal; or, it may consist simply of a distortion of arch forms as, for example, in the V-shaped arch.

If there is too much room in the arch, spacing between the teeth is closed by proceeding directly to Phase II treatment (see page 735) after having first placed round wires, locked distal to the molars, for one month. The purpose of the round wires is to mitigate the shock of initial placement of the flat wires.

A case with too little space in the arch to accommodate the teeth may be converted into one with too much space in one of two ways: first, by extracting dental units and then using the same strategy as noted in the preceding paragraph; or, second, by first moving the molars distally and then using the same strategy as in the preceding paragraph. In the event the entire denture is too far forward in relation to the cranium, extraction of dental units must be a part of the treatment. However, it should not be inferred from this that ex-

traction is accepted as a harmless procedure, but is considered as an expedient in an otherwise hopeless situation.

*Explanation of Treatment Sequence.*—For treatment purposes, each dental arch is divided into three segments: two lateral or buccal segments, each composed of the cuspid and all teeth distal thereto; and one anterior segment made up of the four incisor teeth. The technique is precise and exacting as to the smallest detail. Improperly placed tangs, locks, or bends will certainly influence the final result.

The treatment plan follows four definite phases that must be completed entirely in each dental arch prior to proceeding with the next part of the treatment. In general, treatment of the mandibular arch must progress ahead of that in the maxillary arch. Observance of this rule helps to conserve treatment time, and is imperative during the period that intersegmental spaces are being closed in order to avoid pulling the upper anterior segment lingual to the lower anterior segment. An exception to the rule is followed in the extraction case only during distal movement of the cuspids. Less interference is encountered if the upper cuspids are moved distally ahead of the lower cuspids. Once this has been achieved, the extraction case is treated in the same sequence as the nonextraction case. In either situation it should be stressed that treatment of the maxillary and mandibular arches takes place simultaneously.

Since the majority of the cases in patients treated in the dental clinic of Walter Reed Army Hospital occurred in the category of crowded arches not requiring extractions, this technique is given first.

#### TREATMENT OF CROWDED PERMANENT DENTITION, EXTRACTIONS NOT INDICATED

*Band and Attachment Placement.*—The appliance is fabricated entirely of chrome alloy with parts being welded where indicated. Band construction in general follows the principles applicable to any full-banded appliance. An exception is the position of the twelve anterior bands which are placed so as to cover the middle one-third of the crowns of these teeth. It is believed that by this variation a more accurate fit is obtained, the anterior anchorage is less disturbed, and overbite correction can be managed as satisfactorily in another way.

To secure freedom from binding and ease of manipulation, UT-104 Victory type brackets and UT-111 molar sheaths are used. Never is more than one bracket placed on a band. UT-232 lingual sheaths are used on the molar bands. Labial arches are fastened in the attachments with large size pins, unless otherwise noted.

*Phase I Treatment. The Double Round Labial Arch With Gingival Arch and Coils to Molars—Ends Free.*—

*Objective* (see Plates I to IV): The goal in this phase of treatment is to provide additional arch length by moving, at the same time, both upper and lower molars distally.

*Construction of the Labial Arches.*—Place the double round labial arch in the incisal and occlusal portions of the attachments in this manner. Use a one

foot length of 0.010 inch round wire and bend one-fourth of the length back on itself, first having annealed the point at which the bend is to be made. Insert the doubled end through the occlusal portion of the left molar sheath, and extend the arch distally as far as possible without causing irritation to the soft tissues. The short end of the doubled back wire must lie gingivally in the brackets. Starting at the second premolar, seat the wire in the brackets of the left side, and carry to the left central incisor where the short end is bent gingivally to form a stop at the mesial side of the bracket. Continue seating the

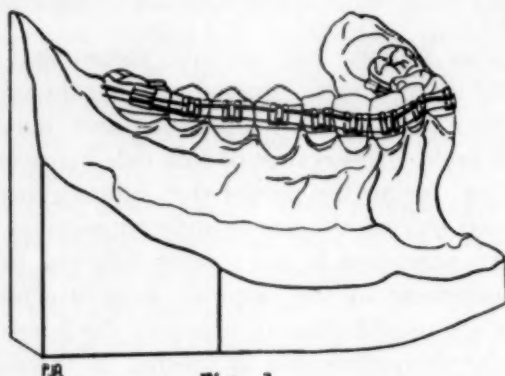


Fig. 1

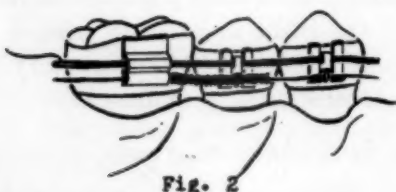


Fig. 2



Fig. 3



Fig. 4

## Plate I.

Fig. 1.—The lower denture at the beginning of Phase I treatment.

Fig. 2.—Note the length of coil prior to compression between the molar sheath and the second premolar bracket; also note the distance the labial arches extend distally from the molar sheath.

Fig. 3.—Shows the coil compressed and the arches pinned in the second premolar bracket.

Fig. 4.—The two central incisors with stops, in the double round labial arch, at the exact mesial of their brackets.

single wire in the brackets of the right side, and when completed, pencil mark the mesial of the right molar sheath onto the arch wire. Remove the wire from the mouth, and on it mark the approximate distal of the right molar sheath. Allowing for an excess length similar to that given the left side, make a bend at this point so that the free end will lie in the gingival part of the occlusal and incisal portions of the brackets. Flame and finish the bend as was done for the left side. Cut off the excess of the stop for the left central incisor (the stop for the right central incisor is not made until the final seating). Insert the arch into the left molar sheath; then place the right end of the arch into the right molar sheath. Pin the arch provisionally in the left cuspid bracket. Place the

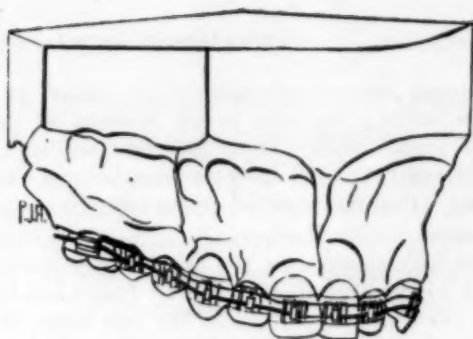


Fig. 1



Fig. 2

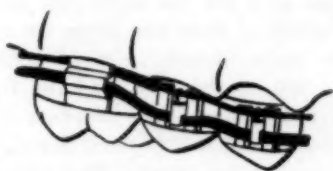


Fig. 3



Fig. 4

Plate II.

Fig. 1.—The upper denture at the beginning of Phase I treatment.

Fig. 2.—Note the length of coil prior to compression between the molar sheath and the second premolar bracket; also note the distance the labial arches extend distally from the molar sheath.

Fig. 3.—Shows the coil compressed and the arches pinned in the second premolar brackets.

Fig. 4.—The two central incisors with stops, in the double round labial arch, at the exact mesial of their brackets.

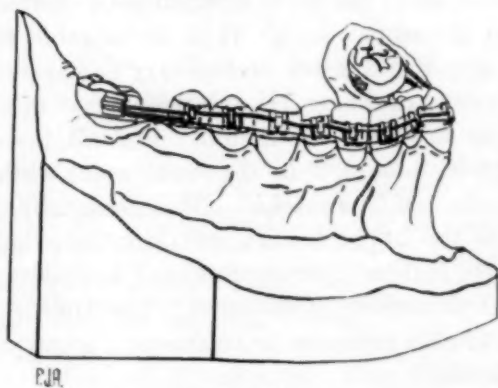


Plate III.

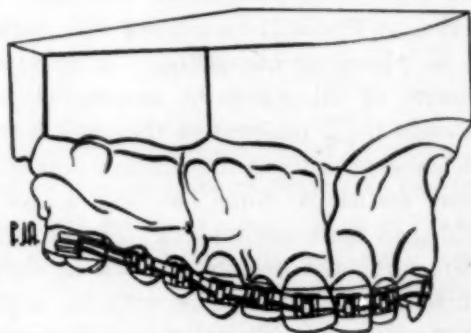


Plate IV.

Plate III.—The lower denture at the completion of Phase I treatment and prior to initiation of Phase II treatment. Note the spacing mesial to the first molar, and how the tooth has moved back along the distal extensions of the labial arches. Should the coil become dislodged during the final stage of this treatment, it is imperative that the patient report at once for placement of the preliminary flat arch and locked gingival arch.

Plate IV.—The upper denture at the completion of Phase I treatment and prior to initiation of Phase II treatment. Note the spacing mesial to the first molar, and how the tooth has moved back along the distal extensions of the labial arches. Should the coil become dislodged during the final stage of this treatment, it is imperative that the patient report at once for placement of the preliminary flat arch and locked gingival arch. The upper arch should not reach this point in treatment until after Phase II treatment has been started in the lower arch.

left central incisor stop exactly against the mesial of the left central incisor bracket. After seating the arch in all brackets of the right side, pin provisionally at the right cuspid. Form the right central incisor stop as was done for the left side, and then lift the wire from the right central incisor and lateral incisor brackets. Cut the stop to proper length, and replace the arch in the lateral and central incisor brackets.

Use 0.012 inch round wire for the gingival arch, and have it previously contoured to a number 104 Hawley chart. Insert one end of the contoured gingival arch in the gingival portion of the left molar sheath, and slip a coil of the proper length onto the arch from the free end (the coil is made of 0.008 inch spring wire wound open on 0.030 inch round wire). Pin the occlusal and gingival arches at the left first premolar. Adjust the gingival wire so the left end protrudes distally through the molar sheath as far as possible without causing gum or cheek irritation. Having first compressed the coil between the second premolar and molar attachments, pin the occlusal and gingival arches at the second premolar. Proceed with the pinning to include the left central incisor. This will necessitate withdrawal of the provisional pin at the left cuspid. In determining the length of the gingival arch for the right side by trial and error, be certain to seat the wire in the gingival slots and allow for the desired amount of distal extension from the right molar sheath. Place a similar length of coil on the wire and insert the right end of the arch into the right molar sheath. Seat the arch in all of the gingival portions of the brackets of the right side and resume pinning the occlusal and gingival arches from the right central incisor to the right second premolar in consecutive order. The provisional pin in the right cuspid must be withdrawn. The right coil is compressed between the attachments of the right second premolar and molar. Check for sharp points or places that may irritate the lips or cheeks. An excess length of stop at the central incisors is one of the most frequent causes of irritation.

*Treatment procedure:* The labial arches for both the maxillary and the mandibular arches are placed at the same sitting. The patient is seen at monthly intervals to check the effectiveness of the coils and to see that the molars are free to slide back along the distal extensions from their respective sheaths. In renewing the coils to the molars, it is undesirable to change both upper and lower coils at the same sitting, since treatment of the lower arch must be carried out slightly in advance of treatment of the upper arch. It is undesirable to arrive at Phase II treatment with both upper and lower preliminary flat arches to be placed at one sitting. It is imperative in Phase III treatment that final closure of all spaces be accomplished in the lower arch first. For all these reasons then, renewal of the coils should be done first in the lower arch, while at the same sitting the original upper coils can be stretched. This assures that some additional force has been added to the upper molars, but less than that added to the lower molars. The procedure is then alternated at each succeeding visit until the desired amount of distal movement is obtained. The time required in Phase I varies with the individual's response to treatment; however, in most cases four months will prove sufficient.

*Special considerations:* Because replacement of the labial arches cannot be made without disturbing the anterior anchorage, plenty of excess wire must be left distal to the molar sheaths, and the stops at the mesial of the central incisors must be definitely formed and accurately placed. The teeth from the left second premolar to the right second premolar are considered a unit of resistance

to the action of the coils mesially; therefore, if spacing is present, or if intervening teeth are missing, or if certain teeth are so malposed as to make pinning of the arches impossible, these gaps must be filled with stiff or dead coil placed on the gingival arch (0.008 inch spring wire wound closed on 0.015 inch or 0.020 inch round wire). In some cases this requirement can be met by moving the central incisor stop to the mesial of the tooth just distal to the spacing; however, a note of caution should be injected since a coupling action may be produced by placing the stop too near the coil. To avoid this torsion which causes the molar to bind on the arch wire, the coil is moved from the gingival arch to the double round occlusal arch. The force of the coil is then in the same plane as the stop. This location of the coil is never as desirable as that on the gingival arch. The double round or occlusal arch should never be disturbed, and the gingival arch disturbed only as necessary to substitute new coils or open old coils. Special note should be made that a lingual arch is not used during this phase of treatment.

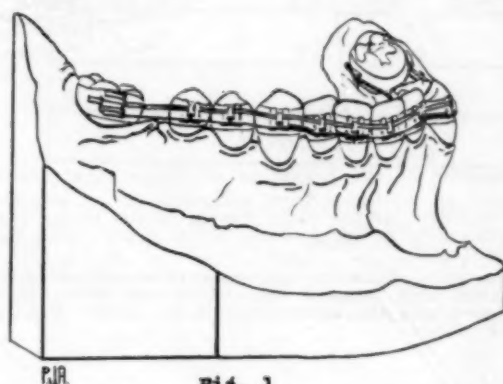


Fig. 1

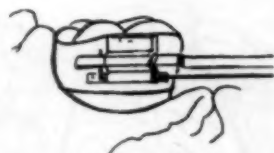


Fig. 2



Fig. 3

Plate V.

Fig. 1.—The lower denture at the beginning of Phase II treatment.

Fig. 2.—The first molar is prevented from returning to its original position by placing a tang in the preliminary flat arch at the exact mesial of the molar sheath. Note the molar offset bend. Forward displacement of the anterior teeth is prevented by locking the gingival arch distal to the molar sheath.

Fig. 3.—The remaining units of the buccal segments are moved distally by placing intersegmental coils on the gingival arch between the cuspids and lateral incisors. This shows the intersegmental coil compressed and the arches pinned in place. Note also the lingual arch ligature around the central incisor.

*Phase II Treatment. The Preliminary Flat Arch With Gingival Arch Locked and Intersegmental Coils.*—The labial arches that were used in the previous treatment are discarded, and a compound impression is taken for the construction of the preliminary lingual arch.

*Objective* (see Plates V to XI): There are several objectives to be achieved during this period of treatment. The newly established arch length must be

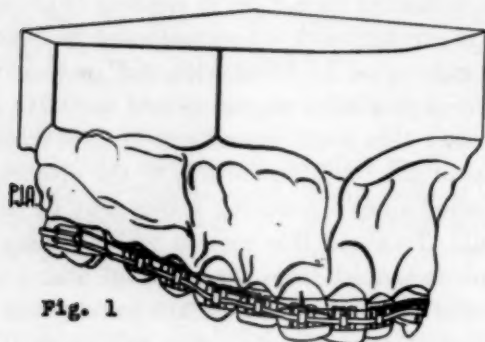


Fig. 1



Fig. 2

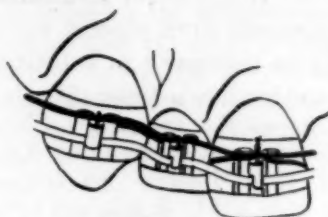


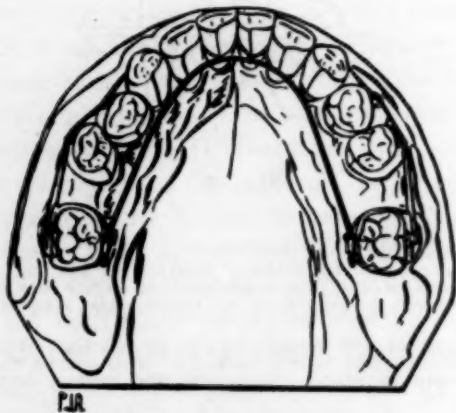
Fig. 3

## Plate VI.

Fig. 1.—The upper denture at the beginning of Phase II treatment.

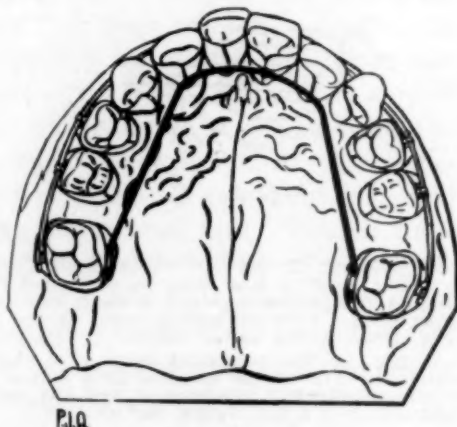
Fig. 2.—The first molar is prevented from returning to its original position by placing a tang in the preliminary flat arch at the exact mesial of the molar sheath. Note the molar offset bend. Forward displacement of the anterior teeth is prevented by locking the gingival arch distal to the molar sheath.

Fig. 3.—The remaining units of the buccal segments are moved distally by placing intersegmental coils on the gingival arch between the cuspids and lateral incisors. This shows the intersegmental coil compressed and the arches pinned in place. Note also the lingual arch ligature around the central incisor.



PJA

## Plate VII.



PJA

## Plate VIII.

Plate VII.—The lower preliminary lingual arch must be contoured to fit the linguogingival margin of the incisors, and to allow for freedom of distal movement of the cuspids and premolars. Its purpose is to correct molar positions. The distance between the arch ends is established by using Erikson's lingual arch chart (see Plate IX). The arch is ligated to one of the central incisors.

Plate VIII.—The upper preliminary lingual arch must be contoured to fit the linguogingival margin of the incisors, and to allow for freedom of distal movement of the cuspids and premolars. Its purpose is to correct molar positions. The distance between the arch ends is established by using Erikson's lingual arch chart (see Plate IX). The arch is ligated to one of the central incisors.

maintained while the remaining units of the buccal segments are moved distally into the spaces that have been created mesial to the first molars. By placing an Atkinson tang in the flat wire mesial to the molars and inserting a lingual arch that is ligated to one of the central incisors, the return of the first molars

LOWER	76	UPPER
	78	90
	80	92
	82	94
	84	96
	86	98
	88	100
	90	102
	92	104

Plate IX.—This is a reproduction of Erikson's lingual arch chart that is based on the measurements of the six anterior teeth and is used to establish the distance between the ends of the preliminary and standard lingual arches. Distances are measured along the horizontal lines from the perpendicular base line on the left to the point at which one of the diagonal lines on the right intersects the horizontal line. The left diagonal line, with the numbers to the left, pertains to the lower arch; the right diagonal line, the numbers to the right, pertains to the upper arch. Numbers on this chart correspond to the numbers of the Hawley charts.

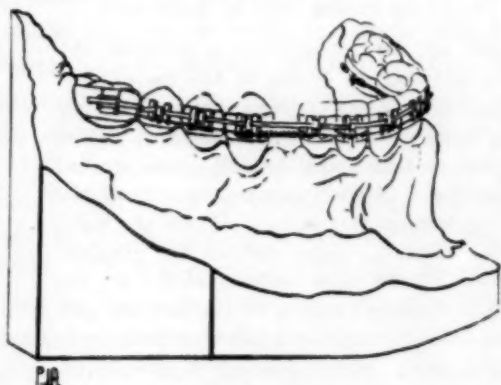


Plate X.

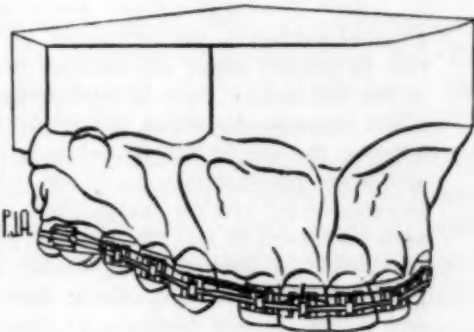


Plate XI.

Plate X.—Distal movement of the buccal segments has been completed in the lower arch which is now divided into three segments: two buccal segments and one anterior segment. All spaces within these segments must be closed. Before proceeding to the next phase in treatment, the preliminary lingual arch must become passive after final adjustment.

Plate XI.—Distal movement of the buccal segments has been completed in the upper arch which is now divided into three segments: two buccal segments and one anterior segment. All spaces within these segments must be closed. Before proceeding to the next phase in treatment, the preliminary lingual arch must become passive after final adjustment.

to their original positions is prevented. The remaining units of the buccal segments are moved distally by placing intersegmental coils between the cuspid and lateral incisor brackets. Forward displacement of the incisors is prevented

by locking the gingival arch distal to the molar sheaths. In preparation for Phase III treatment, positional corrections of the molars are made with the preliminary lingual arch.

*Construction of the Labial Arches.*—The preliminary flat arch is placed in the incisal and occlusal portions of the attachments. Mark the approximate width of the molar sheath on a one foot length of 0.008 inch by 0.028 inch wire. At the mark representing the mesial of the sheath, place a Goslee plier so that the molar offset bend can be made the width of the plier beak to the mesial of the mark. Then, at a point a similar distance from the distal mark, bend the wire so the end will lie buccal to the molar offset bend. Anneal at this point and double the flat wire back on itself preparatory to forming the tang. Do not complete the tang at this time. Insert the flat wire into the left molar sheath and seat in all of the brackets. Mark the mesial of the right molar sheath on the wire. Remove the wire from the mouth and mark the approximate distal of the right molar sheath. Make the right molar offset bend and turn the end of the wire as was done for the left side. Give the wire an approximate arch form and replace it in all of the attachments. Provisionally pin the arch as needed to hold it securely seated in all of the brackets. Two provisional pins are the minimum. More pins must be used if the wire is not completely seated in all of the brackets. Bend out the free ends of the wire on both sides so that definite marks are made on the wire at the exact mesial of the molar sheaths. After removing the arch wire from the mouth, finish the tangs by making a definite right angle bend at the marks made by the mesial of the molar sheaths. Cut the tangs to proper length, and polish with a stone. Give the arch wire the final contour and replace it in the attachments.

As was done in the preceding phase of treatment, use a precontoured 0.012 inch gingival arch. Curl the left end so that progress of the wire, after passing through the gingival portion of the molar sheath, will be facilitated.

*Arch Placement.*—Place the left end of the gingival arch through the gingival portion of the left molar sheath allowing an excess of the curled portion to project above the occlusal surface of the molar tooth. Start pinning at the left second premolar and progress until the left cuspid is pinned. Place a coil of proper length on the gingival arch so that after the coil is compressed between the cuspid and lateral incisor brackets, pinning can continue until the arches are fastened into the bracket of the left central incisor. Place the right intersegmental coil on the gingival arch. Curl the right end of the gingival arch and insert it into the gingival portion of the right molar sheath. An excess should be allowed as for the left side. Resume pinning of the flat and gingival arches to the right side so that the coil is compressed between the cuspid and lateral incisor brackets of the right side. After pinning is completed, grasp the left distal extension of the gingival arch with a pair of Goslee pliers and lock it tightly between the flat arch and the molar band distal to the molar sheath. Cut off the excess level with the occlusal edge of the flat arch. After pulling the right extension of the gingival arch distally, it is locked in the same fashion as was the left side, and the excess removed. Caution the patient about placing his tongue into the spaces mesial to the molars, and explain that these areas must be freed of food by use of the toothbrush.

*The Preliminary Lingual Arch* (see Plates VII and VIII).—Insert the lingual arch at the next visit, having made it on the model that was obtained from the impression taken at the previous sitting. Use 0.030 inch round wire and contour it so that it will not press against the lingual surfaces of the premolars

or cuspids. Failure to observe this point will prevent distal movement of these teeth. When fully seated in the lingual sheaths, the anterior section of the arch must fit accurately at the linguogingival margin of the central incisors. Adjust the arch to slightly overrotate the molars mesiobuccally in preparation for Phase III treatment; also make the necessary adjustments to correct buccolingual and mesiodistal inclinations. Look at the molars' axial inclinations and determine what stresses are required to bring them into the proper relations. Establish the distance between the arch ends by using Erikson's lingual arch chart (see Plate IX). All adjustments having been made and the arch firmly seated into the lingual sheaths, tie the arch with a steel ligature to one of the central incisors.

*Treatment procedure:* For the labial arches, procedure consists of checking the action and renewing the intersegmental coils as required. Rotations in the buccal segments will prevent their distal movement. It may be necessary to reposition attachments if rotations are not corrected by the initial placement of the preliminary flat arch; also construction of new labial arches may facilitate distal movement. The procedure with the lingual arch depends upon the amount of molar correction necessary. The lingual arch usually requires an initial adjustment when first placed, a second adjustment after one to three months, and a final adjustment, after which it may require one to two months to become passive. It is important to record lingual arch adjustments and expected length of time necessary for the arch to become passive.

*Special considerations:* At the start of this phase of treatment, the dental arch is locked as a unit in its new dimension, and is maintained as such throughout the period. There are possibilities for wide variations in the requirements of cases during treatment, and if the requisite of keeping the teeth in the cancellous channel of bone is met, it will be found that the teeth anterior to the molars can be shifted around in this channel almost at will. If movement of posterior segments is lagging, binding in the premolar or cuspid areas may be the cause; however, the most frequent cause is that the patient develops the habit of exploring the space anterior to the molar with the tongue. This is usually initiated by trying to free food from the space. Caution the patient of this at the beginning of treatment; recognize it by space closure on only one side. If the space is not closing on either side, the habit either exists on both sides or there is binding of the brackets. If the tongue habit persists, forced closure is accomplished by ligating the second premolar to the molar as tightly as possible. It is necessary to change to a medium-sized pin in the premolar. The ligature is placed in a way similar to the segmental ligature illustrated in Plate XII, Fig. 2. It is renewed weekly until all spaces in the buccal segment are closed.

The average period of time required for this phase of treatment is four to eight months. Phase III treatment in the lower arch cannot be started until all spaces in the buccal and anterior segments are closed, and molar corrections are completed with the lingual arch passive. Phase III treatment in the upper arch cannot be started until the above requirements are met in the upper arch, and Phase III, Part A, is completed in the lower arch (see Plate XIV).

**Phase III Treatment. The Simple Flat Arch With the Contractile Gingival Arch.**—As previously stated, in progress of treatment the lower arch must be kept in advance of the upper. Failure to observe this rule during Phase III may result in pulling the upper incisors lingual to the lower incisors, or it may even, in the event of a deep overbite, lead to pulling the upper buccal segments mesially while the upper anterior segment remains stationary, locked by the overbite.

After discarding the labial and lingual arches that were used in the last phase of treatment, the next phase is accomplished in three definite, consecutive parts.

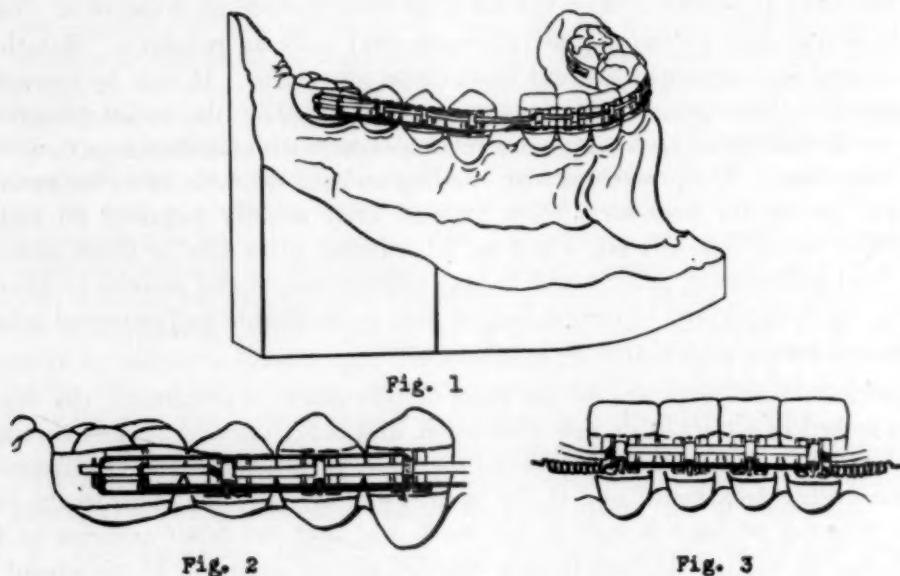


Plate XII.

Fig. 1.—Shows the lower arch in the beginning of Step A, Phase III treatment.

Fig. 2.—The molar offset bend in the simple flat arch is placed close to the distal of the second premolar bracket to allow maximum distal movement before binding at the mesial of the molar sheath. If binding occurs prior to closure of the intersegmental spaces, new labial arches must be made. The flat wire in the molar sheath is of single thickness and free to slide distally through the molar sheath. A segmental ligature prevents spaces developing between the units of the buccal segment.

Fig. 3.—The incisor setback bends are placed in the simple flat arch, and serve to hold the anterior segment as a unit while being carried distally. Tensing the coils integrated into the gingival arch wire closes the intersegmental spaces.

**Part A—Objective** (see Plates XII to XV): The objective is to close the intersegmental spaces existing between the cuspids and lateral incisors by using a gingival arch into which has been incorporated two contractile coil springs.

**Construction of the Labial Arches.**—Make the simple flat arch, that is to be used in the incisal and occlusal portions of the attachments, of 0.008 inch by 0.028 inch wire. Place a setback bend at the distal of the left lateral incisor bracket (in the upper arch, the lateral incisor setback bend must be completed by making an appropriate offset bend at a point sufficiently distal to the adjacent central incisor to obviate binding). Insert the wire into the left molar sheath, and seat in all the brackets of the left side including the central and lateral incisors of the right side of the arch. Draw the setback bend snugly against the distal of the left lateral incisor bracket, and in so doing bend the wire labially over the distal edge

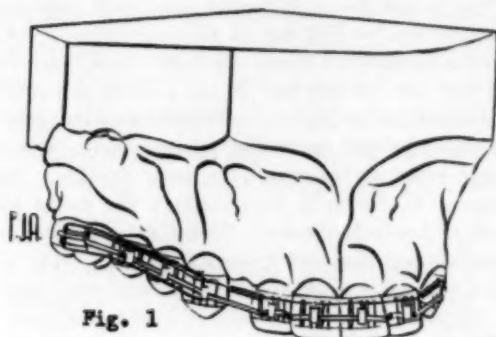


Fig. 1

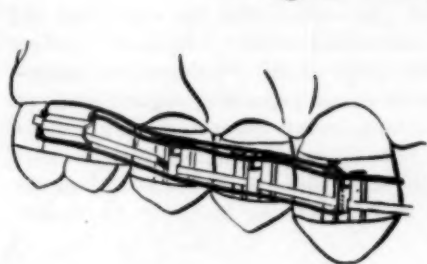


Fig. 2

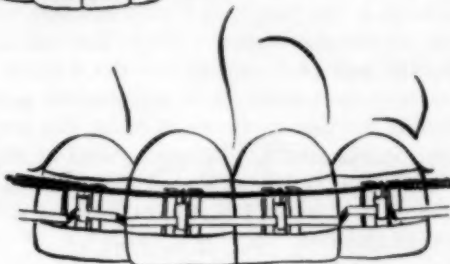


Fig. 3

## Plate XIII.

Fig. 1.—Shows the upper denture in the beginning of Step A, Phase III treatment. This step in treatment of the upper denture cannot be started until the intersegmental spaces have been closed in the lower denture.

Fig. 2.—The molar offset bend in the simple flat arch is placed close to the distal of the second premolar bracket to allow maximum distal movement before binding at the mesial of the molar sheath. If binding occurs prior to closure of the intersegmental spaces, new labial arches must be made. The flat wire in the molar sheath is of single thickness and free to slide distally through the molar sheath. A segmental ligature prevents spaces developing between the units of the buccal segment.

Fig. 3.—The lateral incisor setback bends must be completed in the upper arch by making an appropriate offset bend at a point sufficiently distal to the adjacent central incisor to obviate binding. Tensing the coils integrated into the gingival arch wire closes the intersegmental spaces.

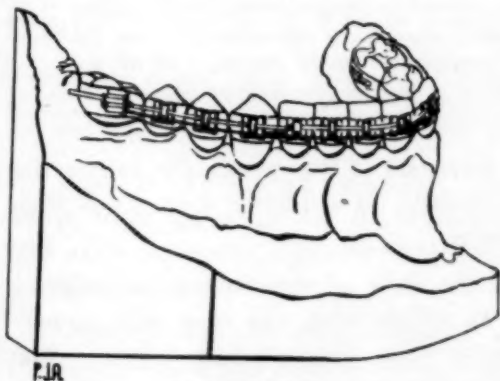


Plate XIV.

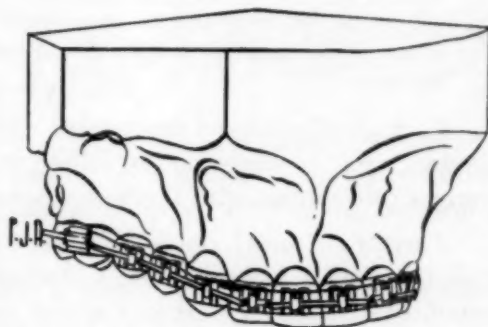


Plate XV.

Plate XIV.—Completed Step A, Phase III treatment. When the intersegmental spaces are closed, the segmental ligatures are removed and an impression is taken for the construction of the standard lingual arch.

Plate XV.—Completed Step A, Phase III treatment in the upper arch. When the intersegmental spaces are closed, the segmental ligatures are removed and an impression is taken for the construction of the standard lingual arch.

of the right lateral incisor bracket. With the arch wire still seated thus, make the following pencil marks on the left leg of the arch wire: the mesial edge of the molar sheath and both mesial and distal edges of the second premolar bracket. Remove the arch wire and cut the left leg of the arch to a length that will allow distal extension from the left molar sheath sufficient to permit locking the gingival arch. Curl the end slightly toward the molar. Incorporate the molar offset bend, making it lie close to the distal of the second premolar bracket. This will allow the maximum distal movement of the arch wire through the molar sheath before encountering the obstacle of the offset bend. Finish the right leg of the arch wire in a similar fashion, and contour the wire to arch form.

Form the gingival arch wire from 0.010 inch round wire into which has been wound two coils that lie just distal to the lateral incisor brackets. First turn ten coils on a one foot length of 0.010 inch wire. Be certain that the ends leave the coil in the same plane. Place the coil at the distal of the left lateral incisor bracket and provisionally pin the wire in the gingival slot of the lateral incisor bracket. Seat the wire in the gingival portions of the remaining incisor brackets. Pulling the coil up to the distal of the left lateral incisor bracket, make a definite bend in the wire at the exact distal of the right lateral incisor bracket. Remove the wire and wind the second coil to lie in the same plane on the arch wire as the first coil. Contour the gingival arch so that the two coils lie on an arc to the outside of the arch.

*Arch Placement.*—Insert both extremities of the flat arch into their respective sheaths and settle the wire into all the brackets. Insert the left extremity of the contractile gingival arch into the gingival portion of the left molar sheath. Pin the arches into the left cuspid bracket, using a medium-sized pin. Insert the right extremity of the gingival arch into the gingival portion of the right molar sheath and pin the arches in the right lateral incisor bracket, using a large-sized pin. Settle the gingival arch into the brackets of the remaining incisors and pin at the left lateral and central incisors. Finish pinning the arches in any desired order, using large-sized pins at all points except the cuspids, where medium-sized pins are used to allow passage of the segmental ligatures through the attachments. Tie each buccal segment into a unit by passing an 0.010 inch ligature through the cuspid bracket and thence around the distal extremity of the flat arch. The free ends of the contractile gingival arch should lie distal to, and not be bound by, these ligatures. After tying the ligatures, tense the contractile gingival arch by pulling distally on each extremity in turn, and locking it into the embrasure between the end of the flat arch and the molar band distal to the molar sheath. Cut off the excess of the gingival arch so that the end is even with the occlusal edge of the flat wire.

*Part A—Treatment procedure:* At intervals of two weeks, the contractile gingival arch is tensed as explained previously. The incisor segment is thus brought into contact with the buccal segments.

*Part A—Special considerations:* If the ends of the contractile gingival arch are pulled too far distally during an adjustment, the coils will be permanently distorted. Best coil action occurs when they are just opened. The pull of the coils is diminished as the lateral incisors approximate the cuspids. Failure to observe this rule may cause unfavorable rotation of the lateral incisors, and a forward movement of the maxillary buccal segments if an excessive overbite is present. Part A should be completed with no tension in the coils. It is necessary to make new labial arches if the molar offset bends bind in the molar sheaths. The maxillary lateral incisor setback bends are important, for

in a large measure these affect the general appearance of the final result. If omitted, or if too little setback is placed, the upper anterior region will have an excessive rounded-out appearance. The amount of setback should be sufficient only to attain an even alignment of the upper incisors along those portions of their lingual surfaces that will eventually come in contact with the labial surfaces of the lower incisors when the patient exhibits normal overbite.

**Part B—Objective** (see Plates XVI and XVII): Since during Part A treatment was given without the use of a lingual arch, molar positions have been disturbed. It is necessary to make final corrections of the molars before proceeding.

*Construction of the Standard Lingual Arch.*—Use 0.030 inch round wire and contour it as shown in Plates XVI and XVII. Follow this ideal form and give it the exact dimension between the extremities according to the lingual arch chart.

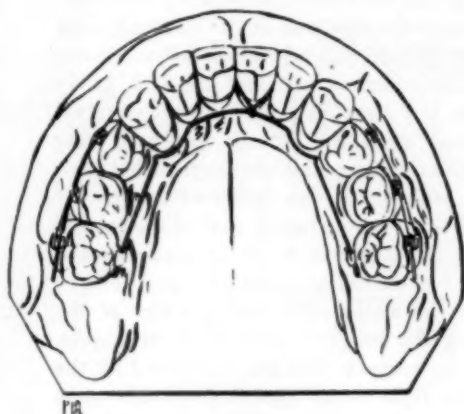


Plate XVI.

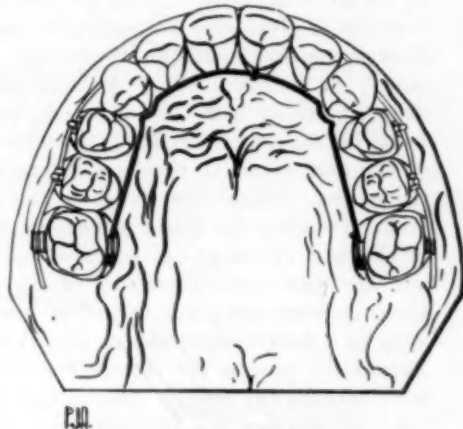


Plate XVII.

**Plate XVI.**—Step B, Phase III treatment, lower arch. Note the contour of the standard lingual arch at the lingual of the cuspids. The distance between the arch ends is established by using Erikson's lingual arch chart (see Plate IX). The standard lingual arch must become passive after final adjustment before proceeding to the next step in treatment of the lower denture. The arch is ligated to one of the central incisors.

**Plate XVII.**—Step B, Phase III treatment, upper arch. Note the contour of the standard lingual arch at the lingual of the cuspids. The distance between the arch ends is established by using Erikson's lingual arch chart (see Plate IX). The standard lingual arch must become passive after final adjustment before proceeding to the next step in treatment of the upper denture. The arch is ligated to one of the central incisors.

**Part B—Treatment procedure** (refer to page 738, Treatment Procedure). When final adjustment of the standard lingual arch is made, it is so recorded, and after the arch is passive it is never again disturbed during the remaining treatment of the patient.

**Part B—Special considerations:** Part C treatment cannot be started until the standard lingual arch becomes passive after the final adjustment.

**Part C—Objective** (see Plates XVIII and XIX): The overbite is corrected in this final part of Phase III treatment.

*Construction of the Labial Arches.*—Utilize the simple flat arch that was used in Parts A and B of treatment with alterations as will be explained. Carefully remove the flat arch from the brackets, and, before washing, locate the marks left by the cuspid and first premolar brackets on each side of the arch.

Make a step on each side that will throw the incisal section of the arch gingivally. Start the steps at the mesial of the first premolar brackets and complete them at the distal of the cuspid brackets so they lie wholly within the space intervening between these two brackets. The steps must not encroach upon the premolar or cuspid brackets. Retain the molar offset bends and lateral incisor setback bends. Alter the arch in no other way, unless the distal extensions from the molar sheaths are too long. In such case, cut off the excess, but allow sufficient length to permit locking the gingival arch when ready. Check contour and three planes of the arch wire.

Fashion the standard gingival arch from a precontoured 0.012 inch round wire. After placing a setback bend for the distal of the left lateral incisor, carry the wire into the brackets of the incisors and mark the distal of the right lateral incisor; allow for considerable freedom between the bends. Remove and complete the setback bend for the right lateral incisor. For the upper arch, form the lateral incisor setback bends as was done in constructing the upper simple flat arch. Curl the left end of the gingival arch and place it into the occlusal portion of the left molar sheath; hold the right side of the wire on the outside of the cheek. Seat the gingival wire in the gingival portions of the brackets of the left and right sides as far back as the first premolars. Centering the lateral incisor setback bends exactly on the distal wings of the lateral incisor brackets, and with the arch firmly seated, mark on both the right and left sides the distal extremity of the gingival wing of the cuspid brackets and the mesial extremity of the gingival wing of the first premolar brackets. Remove the arch wire and place steps between the marks. Make these steps in the same manner as was followed in the flat arch. To mark the mesial extremity of the left molar sheath, seat the left side of the arch in the proper position and mark the mesial side of the molar sheath and also the distal extremity of the second premolar gingival wing. Remove the arch wire and place the offset bend for the molar. Cut the left end of the arch to a length sufficient to permit locking the gingival arch at a later date. Repeat the process for the right side, making certain that the right end of the wire extends far enough distally through the right molar sheath to permit locking. *Do not lock the gingival arch.* Check contour and three planes of the arch wire.

*Arch Placement.*—Place both arches in their respective brackets. Pin the arches in the left cuspid brackets, and then in the right lateral incisor brackets. Center the incisor setback bends on the distal of the lateral incisor brackets. Pin the arches in the remaining incisor brackets and also the right cuspid. Next pin the arch wires in the brackets of the first premolars, holding the flat arch firmly down into the occlusal slot of the attachments. Pin the arches in the second premolar brackets. Do not lock the gingival arch at this sitting, but have the patient return in one week for locking.

*Part C—Treatment procedure:* The gingival arch is not locked for one week. This allows the steps that are distal to the cuspids to recover from the initial distortion caused during placement. At the end of this recovery period it is extremely important to follow these instructions: remove both first premolar pins and repin the arches while holding the flat wire all the way down in the brackets; make certain that the gingival arch is centered over the lateral incisor brackets, and then lock the gingival arch distal to the molar sheaths. Care must be taken not to pull the gingival arch off center during the locking process. A minimum of two months should be allowed for the teeth to adapt themselves after locking the gingival arch. The lingual arch is not disturbed during this last part of Phase III, since the lingual arch work must be completed prior to proceeding to Part C.

*Part C—Special considerations:* Special attention to the placement of the steps in both the flat arch and the gingival arch is necessary (see Fig. 4, Plates XVIII and XIX). Unless the gingival arch is locked at the time indicated, spacing will probably occur at the distal of the lateral incisors. The degree of step is governed by the overbite correction that may be indicated. A total of nine months is the average length of time required to complete the three parts of Phase III treatment.

*Phase IV Treatment. The Standard Flat Arch and the Standard Gingival Arch.*—

*Objective:* By contouring the labial arch wires to the appropriate Hawley chart, final corrections of intra-arch tooth positions are effected. For this an

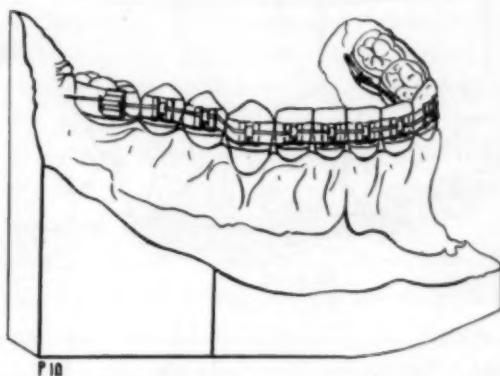


Fig. 1



Fig. 2



Fig. 3

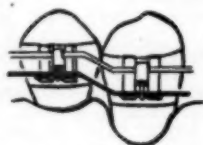


Fig. 4



Fig. 5



Fig. 6

Plate XVIII.

Fig. 1.—Step C of Phase III treatment: the simple flat arch with steps, and the standard gingival arch with steps and locked.

Fig. 2.—This shows the simple flat arch and standard gingival arch extensions from the molar sheath. Note that the ends of the standard gingival arch are left free for a period of one week. This permits the steps to recover from the distortion caused by initial placement.

Fig. 3.—After one week the arches are repinned in the first premolar brackets, and the standard gingival arch is locked distal to the molar sheaths.

Fig. 4.—Steps are placed in both the flat arch and the gingival arch. These steps must be located wholly within the space intervening between the distal of the cuspid bracket and the mesial of the first premolar bracket. The flat arch must be held firmly down in the first premolar bracket while the pin is locked.

Fig. 5.—Lateral incisor setback bends are retained in both the simple flat arch and the standard gingival arch. There is no change from this in constructing the standard flat arch that is used in Phase IV treatment.

Fig. 6.—In Phase IV treatment, tangs are placed at the mesial of the first molars, and the standard gingival arch is locked after pinning is completed.

0.010 inch by 0.028 inch flat wire is used which, in conjunction with the locked gingival arch, ties the dental arch as a unit in preparation for elastic work if later indicated.

*Construction of the Labial Arches.*—Use an 0.010 inch by 0.028 inch hard drawn wire for the standard flat arch. Make lateral incisor setback bends in the same manner as was done in Phase III. Seat the flat wire in the incisor, cuspid, and first premolar brackets and proceed to form the steps as was done in Phase III, Part C. After forming the steps, reseal the wire and mark the second premolar brackets and the mesial of the molar sheaths. Make molar-offset bends and tangs at the mesial of the molars in the same way as was done in Phase II. Contour the flat arch to conform to the appropriate Hawley chart.

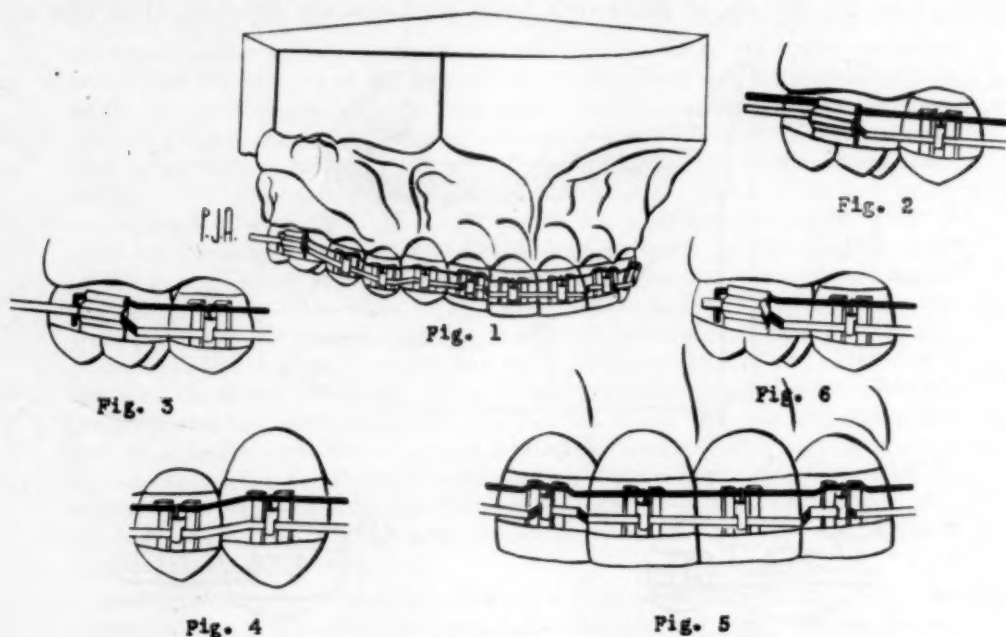


Plate XIX.

Fig. 1.—Step C of Phase III treatment: the simple flat arch with steps, and the standard gingival arch with steps and locked.

Fig. 2.—This shows the simple flat arch and the standard gingival arch extensions from the molar sheath. Note that the ends of the standard gingival arch are left free for a period of one week. This permits the steps to recover from the distortion caused by initial placement.

Fig. 3.—After one week the arches are repinned in the first premolar brackets, and the standard gingival arch is locked distal to the molar sheaths.

Fig. 4.—Steps are placed in both the flat arch and the gingival arch. These steps must be located wholly within the space intervening between the distal of the cuspid bracket and the mesial of the first premolar bracket. The flat arch must be held firmly down in the first premolar bracket while the pin is locked.

Fig. 5.—Lateral incisor setback bends are retained in the simple flat arch and in the standard gingival arch. There is no change from this in constructing the standard flat arch that is used in Phase IV treatment.

Fig. 6.—In Phase IV treatment, tangs are placed at the mesial of the first molar sheaths, and the standard gingival arch is locked after pinning is completed.

Use the same standard gingival arch that was used in Part C of Phase III. If it is not in good condition and cannot be used, fashion a new one. The gingival arch must also be contoured to the appropriate Hawley chart.

*Arch Placement.*—Pin the arches in the brackets in the same way as was done in Part C of Phase III. Take care to push the flat wire all the way down into the first premolar brackets when pinning. Since no distortion of the steps should now occur, lock the gingival arch at this same sitting, and with the same precautions taken previously.

*Treatment procedure:* These final arches remain in place for one month, or until they are passive, before proceeding with treatment. The lingual arches are not disturbed.

*Intermaxillary Elastics.*—It is not until Phase IV is completed and the final arches have become passive that consideration is given the necessity for intermaxillary elastics. If further correction, or overcorrection, of the anteroposterior relation of the arches is desirable, the cuspid pins are removed and replaced by a similar pin that is fashioned from 0.016 inch round wire. This special pin is placed through the bracket, bent forward to form a hook, and the end doubled on itself so that it will not irritate the lips. The distal extension of the flat wire from the molar sheaths is used as the elastic attachment in the opposing arch.

In treating an undesirable anteroposterior relationship of the dental arches, it is almost always indicated to overcorrect the condition.

If an open-bite exists after final arch wire treatment is completed, vertical elastics are placed by removing the lateral incisor pins and substituting the specially formed pins as outlined previously herein. One elastic is then placed on the lateral incisor hooks of the upper arch and pulled down over the hooks of the lower arch, thus forming a four-way elastic.

Midline corrections are made by applying the elastic traction over the hooks in such a manner as to give a diagonal pull in the direction indicated.

*Retention.*—After the elastics have made the necessary final corrections, arrangements are made to remove the appliances and retain the position of the teeth. Atkinson's modifications of the Hawley retainers are constructed and placed as soon as possible.

Three to four weeks after placement, the retainers are checked; and again at the end of three months final adjustments are made. Six months from the time of insertion, the patient is placed on night wearing only, and is called for observation at six-month intervals thereafter. After three or four years, the interval between observations may be extended to one year.

#### TREATMENT OF CROWDED PERMANENT DENTITION, EXTRACTIONS INDICATED

*Band and Attachment Placement.*—In addition to the same general requirements that were discussed previously, it is necessary to extend the banding to include the second molars. The buccal and lingual sheaths are placed on the second molar bands, while the Victory type brackets are attached to the first molar bands. Eyelets may also be placed on the first molar bands so that rotation can be corrected. Never is more than one bracket placed on a band. Placement of the bands can be started as soon as the extraction sites have healed and the soreness of the proximate teeth has sufficiently subsided.

*Phase I Treatment.*—But for the exceptions that follow, the arch wires used in this phase are identical to those employed in the nonextraction case. Coils are placed in the intersegmental positions (between the lateral incisors and the cuspids), and the gingival arch is locked distal to the molar sheaths. The preliminary lingual arch is placed as soon as practicable. It is modified in contour, just mesial to the first molars, by placing setback bends to the lingual

that will compensate for the greater buccolingual dimensions of the first molars as compared with the second premolars. Failure to observe this will cause undue buccal pressure to the first molars and distort the arch. Since the lingual arch is attached to the second molars, the ends must be worked three sizes larger than would be indicated by Erikson's lingual arch chart. The labial arches are left in place for approximately one month to serve the purpose of leveling off the brackets and diminishing the shock of the initial placement of the flat arch.

*Phase II Treatment.*—The upper cuspids are moved distally ahead of the lower cuspids; therefore the upper preliminary flat arch, with locked gingival arch and intersegmental coils, is inserted prior to that for the lower arch. In other respects, treatment is conducted as was described for the nonextraction case.

*Phase III Treatment.*—Parts A and B are the same as for patients being treated without extractions (see pages 742 and 743). The standard lingual arch is modified as was noted for the preliminary lingual arch, and it is also worked three sizes larger on the lingual arch chart.

Part C treatment varies from the routine procedure since in the extraction case there is a tendency for the cuspids to be tipped distally and for the second premolars to be tipped mesially during closure of the first premolar spaces. Stability of the treated denture depends upon correcting these errors in axial inclination. By altering the steps in the gingival arch, the correct axial inclinations are given these teeth. Proceed with step formation in the flat wire as was recorded on page 743, and in a like manner start formation of the gingival arch until ready to mark the gingival wings of the second premolar and cuspid brackets. Both mesial and distal extremities of the gingival wings of the second premolar and cuspid brackets must be marked before removing the wire and forming the paralleling bends and steps as follows. The first bend is formed slightly to the mesial of the cuspid mark and in such a way as to throw the anterior portion of the arch gingivally. The next bend is made slightly to the mesial of the premolar mark and in the opposite direction to that of the first bend. The last bend is completed slightly to the distal of the premolar mark and in a direction opposite to the preceding bend. Placement and treatment procedure follow that already given.

*The Remaining Treatment.*—Treatment in Phase IV, intermaxillary elastics, and retention are identical to that already given on page 747. Treatment of patients with extractions should be completed about four months sooner than that of patients without extractions, since distal movement of molars has not been a part of the treatment. The total average time required for treatment is eighteen to twenty-two months.

#### TREATMENT OF MIXED DENTITION CASES

Treatment of the deciduous dentition has not been made a part of this thesis, because it is believed that any one of several methods of correction may be employed with equal effect. In the mixed dentition, however, the problem may be quite different, and with effective strategy much may be accomplished

to the benefit of the succeeding permanent dentition. Since the approach is somewhat different from that generally employed, inclusion of the following material was considered to be pertinent.

In general the pattern of treatment for the mixed dentition case is very similar to that given in detail for the crowded permanent dentition, extractions not indicated, and for this reason only the required deviations are recorded.

*Band and Attachment Placement.*—The general requirements that were discussed for the permanent dentition apply also in the treatment of the mixed dentition. The dental developmental age of the child should be such that bands can be placed on the eight permanent incisor and four permanent first molar teeth. Although it is most desirable to have all of the deciduous cuspids and molars banded throughout the treatment, at times banding the deciduous first molars may be omitted if their exfoliation is anticipated within a few months after the initiation of treatment. It is imperative that the intervening spaces, occasioned by omitting the deciduous first molar bands, be filled with stiff coil (see page 735) placed on the gingival arch. Victory type brackets are placed on the deciduous molar bands, and, as in treating the permanent dentition, only one bracket per band.

*Phase I and Phase II Treatment.*—In Phase I and Phase II treatment there is only one deviation from the established routine and it pertains to the lingual arches. These differ from the lingual arches used in treatment of the permanent dentition without extractions in two respects: first, in width they are three sizes larger than indicated by Erikson's lingual arch chart based on the measurement of the six anterior teeth and second, because of interference from the second deciduous molars, the arch wire must in some cases be given an offset to the lingual to obviate undue buccal pressure on the second deciduous molars.

*The Remaining Treatment.*—Phase III treatment is varied as pertains to overbite correction, this part being omitted.

The final ideal arch wires are placed in Phase IV treatment, steps being omitted. To provide hooks for elastics in the upper arch, a spanner which is similar to the sliding jig is constructed of 0.022 inch round wire and placed on the upper standard flat arch.

The procedures with intermaxillary elastics and retainers are similar to those used for the permanent dentition. Retainer design must be reconsidered when the remaining permanent dentition has erupted.

The average time required for treatment is twelve to eighteen months.

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## PREVALENCE OF MALOCCLUSION IN CHILDREN AGED 14 TO 18 YEARS

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### INTRODUCTION

SINCE malocclusion affects a large segment of the population, it is by definition a public health problem. As in any other phase of public health work, it is essential to have accurate information on the prevalence and incidence of the condition. Prevalence figures obtained from studies made to date vary greatly. There is little reliable information available largely because the criteria of assessment of normal and abnormal occlusion have varied with each study. A method of assessing malocclusion in large population groups for epidemiologic purposes is herein suggested. This method is simple and is subject to statistical discipline. It was the purpose of this study to test the usefulness of this method and to accumulate reliable epidemiologic data on the prevalence of malocclusion in a group of children 14 to 18 years of age.

### REVIEW OF THE LITERATURE

*Incidence of Malocclusion.*—A search of the literature for information concerning the prevalence and incidence of malocclusion revealed the fact that while such studies have been carried out sporadically since 1889, the figures obtained show little agreement with each other. The results of these studies were analyzed as far as the published data permitted and are presented in Fig. 1. The wide range in the findings are obvious. The reasons for this appeared to be three-fold. First, the criteria of assessing normal and abnormal occlusions varied considerably. This in itself laid the basis for considerable variations in the figures obtained. Second, a wide range of different age groups were studied with the result that data on the primary, mixed, and permanent dentitions are inextricably mixed, one with the other. Third, in some studies only a small number of individuals were examined so that the findings were statistically of doubtful significance.

*Methods of Assessing Malocclusions.*—A number of methods of assessing and classifying malocclusions have been proposed since 1889. They range from a simple designation of "regular" and "irregular" occlusion (without, however, any definition of these terms) by Ottofy (1888) to complicated systems proposed by Hellman (1921), Simon (1926), Korkhaus (1928), McCall (1944), Selare (1945), and Moore (1948). Most of the methods of assessment were based upon Angle's designation of "normal" and "abnormal" occlusion which

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he published in 1907. Most of the classifications in use today are, therefore, also based upon Angle's designation of molar relationships and Class I, Class II, and Class III malocclusions. A few (Hellman 1921; Korkhaus 1928) include also a designation of the relationships of the anterior segments.

However, all these methods of assessment and classification were designed to serve the needs of practitioners (orthodontists) who were primarily interested in the diagnosis and method of treating the individual case. They were not designed to serve the needs of the epidemiologist. In general, the various methods of classification depend upon special training of the observer and are subjective in character. The data derived by such methods do not lend themselves easily to statistical analysis.

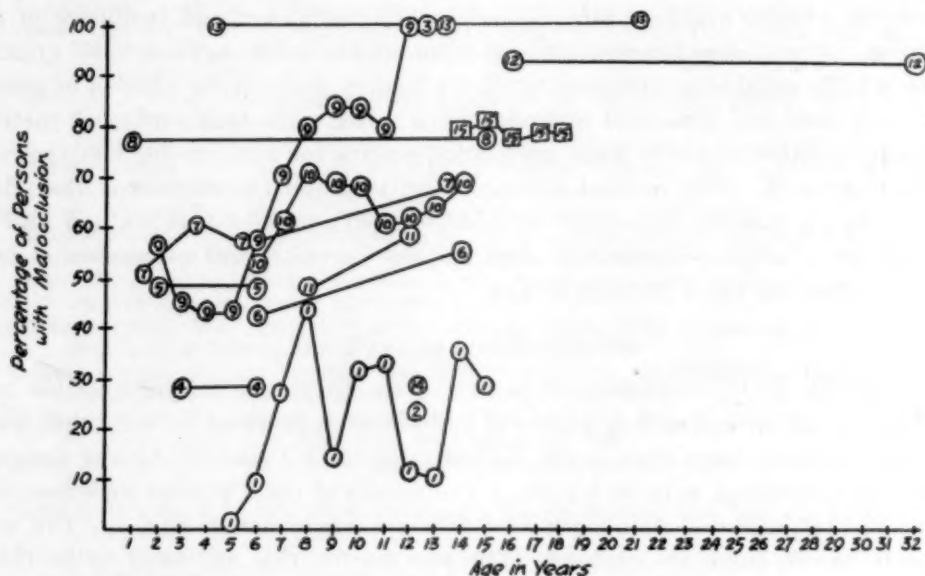


Fig. 1.—Analysis of data published on the incidence of malocclusion. Numbers refer to the following sources:

- |                     |                                |                              |
|---------------------|--------------------------------|------------------------------|
| 1, Ottofy, 1888     | 6, Korkhaus, 1928              | 11, Sclare, 1945             |
| 2, Talbot, 1890     | 7, Stallard, 1932              | 12, Huber and Reynolds, 1946 |
| 3, Angle, 1907      | 8, Taylor, 1935                | 13, Seipel, 1946             |
| 4, Chiavaro, 1915   | 9, Goldstein and Stanton, 1936 | 14, Moore, 1948              |
| 5, Thielemann, 1923 | 10, Munblatt, 1943             | 15, Present Study            |

*The Epidemiologic Approach.*—The basic difference in the viewpoints of the clinician and the epidemiologist largely determines the different methods used by each. The clinician is concerned with the person suffering from the disease (i.e., the effects of the disease upon the individual) while the epidemiologist is primarily concerned with the characteristics of the disease itself (i.e., its extent, pattern of distribution, and behavior). To the epidemiologist, the patient is an abstract concept called "the average person."

The different objectives and methods employed by the clinician and the epidemiologist are exemplified in the problem of dental caries. The epidemiologist counts the number of persons affected by caries (prevalence rate) at successive age levels (incidence) and the number of teeth affected by caries

(DMF Index). Such simple methods of assessment and the data obtained from the examination of large groups of individuals with such methods have been invaluable in caries research. It has led to such important findings as the inverse relation of caries to the fluoride content in the communal water supply. Nonetheless, the epidemiologic method is of little value to the dental practitioner when he is faced with the problem of the treatment of caries in a single individual. His analysis of the caries problem in that particular person must include such details as the surfaces involved, the depth and extent of the cavitation, the effects of the caries upon the health of the pulp and on the occlusion of the adjacent teeth. For such purposes a statement of the number of carious teeth only is inadequate. It conveys too little information for his needs. The clinical method of assessment must involve the use of radiograms, lactobacillus counts, and other time-consuming procedures necessary to clinical evaluation and proper treatment.

The epidemiologist is primarily concerned with quantitative data on the prevalence rate and incidence of the disease. He is, ultimately, concerned with the *prevention or control of the disease in the mass* of the population and not with the treatment of the disease or *the correction of its effects in a single individual*. The latter is the concern of the dental practitioner.

It is only in recent times that any attempt has been made to define the problem of malocclusions from the public health point of view. Sclare (1945) and Moore (1948) both felt that, from the public health point of view, the problem resolved itself into a question of how much orthodontic treatment was needed in a given group of individuals. This method, while coming much closer to defining the problem of malocclusion in epidemiologic terms, requires the services of a well-trained orthodontist as the examiner, and is necessarily subjective.

If reliable information is to be obtained on the prevalence of malocclusion, a technique of investigation should be applied which will satisfy the following criteria:

1. It must be simple, accurate, and applicable to large groups of individuals.
2. It must yield quantitative information which will lend itself to statistical analysis.
3. It must be reproducible so that one group can be compared with another.

#### METHODS OF ASSESSMENT USED IN THIS STUDY

This article suggests a quantitative method of evaluating the amount of malocclusion in large groups for epidemiologic purposes. This method uses the individual tooth as *the unit of occlusion* rather than a segment of the arch. Each tooth is examined to determine whether it is in correct occlusion or is maloccluded. The number of maloccluded teeth in each individual is then counted and recorded. The total number of maloccluded teeth per person is the basis for the evaluation of the prevalence and incidence of malocclusion in large groups of individuals.

This method has only the virtue of being simple and lending itself to quantitative manipulations. It is, in addition, fairly objective and reproducible since

the classification of the malocclusion (either the type or treatment required) is not necessary, and the subjectivity inevitable to any system of classification is avoided.

*Definition of a Maloccluded Tooth.*—In 1907, Angle stated that a tooth could be maloccluded in any one of seven positions or combinations of positions. These were described as:

1. Buccal (labial)
2. Lingual
3. Mesial
4. Distal
5. Torsoocclusion (rotation)
6. Infraclusion
7. Supraclusion

Angle's variations were modified for the purpose of this study by combining some (a tooth could not be both buccal and lingual or mesial and distal at the same time, nor could it be both supracluded and infracluded), and adding the category of "missing" tooth. Therefore, the following descriptive classification of malpositions was used:

1. Buccal (labial) or lingual displacement
2. Mesial or distal displacement
3. Rotated
4. Infracluded or supracluded

A given tooth can therefore be in only one of three positions within the arch: correct occlusion, malpositioned, or missing. If malpositioned, the tooth can be displaced in as many as four different spatial relationships. For example, a tooth can be out of the line of occlusion both buccally and distally; it can also be rotated and supraerupted, all at the same time. The exact malposition of each tooth was noted by appropriate symbols on the recording sheet (Figs. 2 and 3).

*Method of Inspection.*—Each tooth was examined twice and from two different aspects in order to determine whether it was in good occlusion or malpositioned. The child was seated in good light, and the examiner, using an ordinary dental mouth mirror, examined first the occlusal surface aspect of the arches, with the jaws apart (Fig. 2), and then the buccal and labial surfaces, with the teeth in occlusion (Fig. 3).

The first examination consisted of an inspection of each tooth from the occlusal view of each arch in order to determine best its relation to the adjacent teeth and to the *contact line* (Fig. 2). The contact line may be defined as that line connecting the contact areas of each tooth so that a continuous arch line results. Any tooth which was not in exact alignment with the contact line was considered as being out of line and therefore malpositioned. This inspection quickly revealed those teeth which were displaced buccally or lingually from their correct and ideal position in the arch or were rotated (Fig. 2). Mesial or distal displacements and infra- or supraeruptions were not as easily noted from this view as in the subsequent inspection.

After each tooth in each arch had been carefully inspected from the occlusal view and the displacement of each maloccluded tooth noted in the appropriate box of the record sheet, the child was told to occlude the teeth. Care was taken to see that the correct bite was registered. The interdigitation of the teeth was then inspected from the buccal and labial aspect in the occluded position. The relation of each tooth to the *plane of occlusion* was readily revealed by this inspection as was the interdigitation of the teeth as defined by Angle (1907).

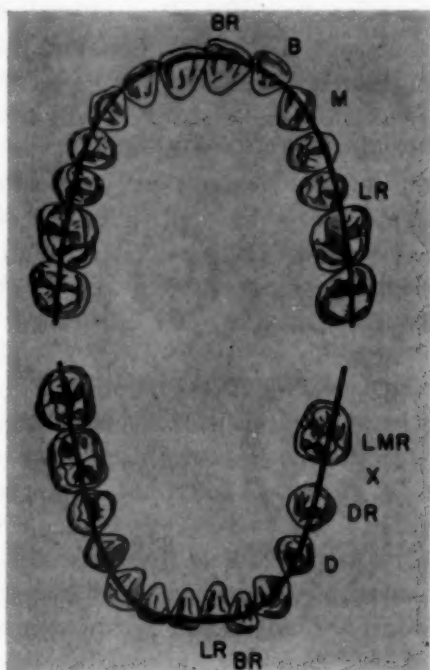


Fig. 2.

Fig. 2.—Occlusal view of the teeth in normal and abnormal relation to the contact line.

- BR, Labial displacement and rotated
- B, Labial displacement
- M, Mesial displacement
- LR, Lingual displacement and rotated
- LMR, Lingual and mesial displacement, rotated
- X, Lost by extraction
- DR, Distal displacement and rotated
- D, Distal displacement

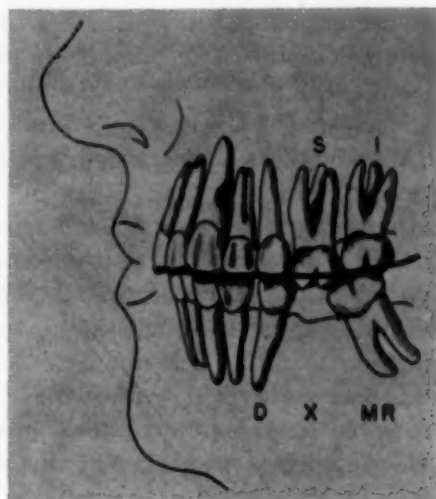


Fig. 3.

Fig. 3.—Buccal view of the teeth in normal and abnormal relation to the plane of occlusion (as defined by Angle).

- S, Supra-erupted
- I, Infra-erupted
- D, Distal displacement
- MR, Mesial displacement and rotated
- X, Lost by extraction

This view readily revealed supra- and infraeruptions of the teeth (Fig. 3). Deviations from the ideal plane of occlusion and deviations in the curve of Spee were readily defined from this aspect. The mesiodistal relationships of the individual teeth were also best discerned from this point of view, and, in fact, the classification of the type of malocclusion is commonly made in this fashion from occluded models.

Each tooth was thus inspected twice and its position in the arch critically evaluated two times.

*Recording.*—In all cases, even minor deviations from the contact line and the ideal plane of occlusion, as defined by Angle (1907), were noted in the appropriate box of the record sheet. The occlusal and buccal examinations were recorded separately. The exact deviation of each tooth from its ideal position in the plane of occlusion could thus be readily recorded without the necessity of making time-consuming models of the teeth and arches of each child.

*Evaluation of the Maloccluded Tooth.*—Any tooth which was not in perfect occlusion from both the occlusal aspect (in perfect alignment with the contact line) and the buccal aspect (in perfect alignment with the plane of occlusion and in correct interdigitation with the opposing teeth) was considered as being maloccluded. The third molars were not considered in this study.

Each maloccluded tooth was assessed a value of one without regard to the degree of its displacement. Thus a given tooth might have been recorded as having been malposed in four different ways, but was counted only once as one maloccluded tooth. The number of maloccluded teeth in each individual was then counted, and this figure used in all subsequent analyses. The evaluation of the occlusion of a given individual resulted in a number from zero (0) for a dentition with no maloccluded teeth to twenty-eight (28) if all of the teeth were maloccluded.

Missing teeth were considered only as absent. The effects of missing teeth upon the occlusion of the contiguous teeth are well known (Salzmann, 1950). The effects of missing teeth, particularly lower first molars, were therefore assessed and counted although the missing tooth was itself not counted as a maloccluded tooth. Newly erupted teeth which had not as yet reached their full occlusal position were not counted as "infraerupted." Rather, this classification was reserved for those teeth which were pathologically prevented from erupting.

Developmental anomalies of the teeth were also noted and recorded on the examination form.

*Classifications.*—

*Angle's classification:* In order to permit comparison of the data obtained in this study with previous findings in the literature, a notation was made of the type of malocclusion according to Angle's classification (Class I, II, or III) in each case where it existed.

*Mild, moderate, and severe malocclusions:* From the clinical point of view, it is often desirable to determine the degree of malocclusion, as well as the type. Toward this end, each case of malocclusion was evaluated (subjectively) as being either *mild* (requiring only very short-term preventive or palliative measures), *moderate* (requiring more prolonged but simple treatment), or *severe* (requiring a long term of intensive or complicated treatment). These categories correspond fairly well with those suggested by Sclare (1945) and by Moore (1948) and were designed to permit some comparison of the data accumulated in the three studies.

*Definition of "Ideal" and "Normal" Occlusion.*—During the analysis of the data it became apparent that the amount of malocclusion in any population group will depend a great deal upon the definition of what constitutes mal-

occlusion. The mere presence of one or two very slightly displaced teeth which in no way interfere with proper function or with esthetics does not constitute a "malocclusion." It therefore became necessary to define "ideal," "normal," and "malocclusion" carefully before analysis of the data could be attempted.

A child was designated as having an "ideal" occlusion when not a single tooth was even slightly out of exact alignment and occlusion. This classification was therefore reserved only for those patients who presented absolute perfection in the positioning of each individual tooth and in the occlusion of both arches. The number of such cases was very small (3 per cent).

"Normal" occlusion was considered to be present in those patients who presented a good interdigitation of both arches but in whom a few teeth were only *very slightly* out of perfect alignment. In these cases no orthodontic treatment was indicated nor desirable. The clinical term "normal" occlusion seemed a proper designation. An analysis of the data showed that this subjective estimate of "normal" was limited to patients with *less* than the average number of 10 malpositioned teeth. The definition of "normal," therefore, was subsequently made to include the quantitative limitation of less than the average number of *very mildly* maloccluded teeth, in addition to the subjective assessment of not requiring orthodontic attention.

The designation of "malocclusion" was reserved for those patients in whom the malpositioning of the teeth was sufficiently severe in degree to *require orthodontic treatment*, and/or any case having more than 10 malpositioned teeth.

#### MATERIALS

Examination was confined to high school students with a complete permanent dentition since it was felt that the evaluation of the status of a mixed dentition could not be made with accuracy. Malocclusion occurring in the mixed dentition is sometimes transitional so that any evaluation might be subject to too great error.

This study was based on the examination of 2,758 children of Morton High School, Cicero, Ill. Their ages ranged from 14 to 18 years. The distribution of children from 14 to 17 years was fairly equitable (Table I). The 18-year-old group was much smaller. There was an almost equitable distribution between boys (1,238) and girls (1,520) (Table I). Almost all of the children enrolled in the school were examined. There was no selection except for elimination of those children receiving orthodontic treatment and those few who still had mixed dentitions.

*Ethnic Origin and Economic Condition.*—The children came from a fairly uniform ethnic stock, primarily Polish and Bulgar. The families were in the upper middle class of skilled laborers employed in manufacturing. The community was a highly industrialized one.

*Nutritional Status and Dental Care.*—The group was above average nutritionally and received good dental care. Gold restorations were commonly seen, and a number of the children (107 or 3.9 per cent) were receiving orthodontic treatment.

TABLE I. NUMBER OF MALOCCLUDED TEETH IN CHILDREN FROM 14 TO 18 YEARS OF AGE

AGE IN YEARS	NUMBER OF CHILDREN EXAMINED			TOTAL NUMBER OF MALOCCLUDED TEETH			AVERAGE NUMBER OF MALOCCLUDED TEETH PER CHILD		
	MALE	FEMALE	COMBINED	MALE	FEMALE	COMBINED	MALE	FEMALE	COMBINED
14	209	344	553	2378	3467	5845	11.38	10.08	10.56
15	314	414	728	3318	4465	7783	10.57	10.78	10.69
16	331	367	698	3578	3470	7048	10.81	9.45	10.09
17	303	351	654	3353	3685	7038	11.07	10.50	10.76
18	81	44	125	945	444	1389	11.67	10.99	11.11
14 to 18	1,238	1,520	2,758	13,572	15,531	29,103	10.96	10.22	10.55

## FINDINGS

*Ideal, Normal, and Malocclusion.*—Ideal occlusion was found in only *circa* 3 per cent of the children. Normal occlusion (less than 10 very mildly malposed teeth requiring no orthodontic correction) was found in 18.2 per cent of the children. This means that, clinically, malocclusion was absent in 21.2 per cent of the children or, conversely, 21.2 per cent of the children had a "good" occlusion which did *not* require correction (Table II).

TABLE II. DISTRIBUTION OF OCCLUSION ACCORDING TO ANGLE'S CLASSIFICATION (MALES AND FEMALES COMBINED)

"GOOD" OCCLUSION					MALOCCLUSION			
AGE IN YEARS	NUMBER OF CHILDREN EXAMINED	"IDEAL" OCCLUSION*	"NORMAL" OCCLUSION†		CLASS I	CLASS II, DIV. 1	CLASS II, DIV. 2	CLASS III
		No. (%)	No. (%)		No. (%)	No. (%)	No. (%)	No. (%)
14	553	21 (3.80)	98 (17.72)		283 (51.17)	85 (15.37)	14 (2.53)	52 (9.40)
15	728	19 (2.61)	125 (17.17)		367 (50.41)	129 (17.73)	27 (3.70)	61 (8.38)
16	698	21 (2.89)	135 (19.34)		341 (48.85)	113 (16.21)	19 (2.71)	69 (9.90)
17	654	19 (2.91)	118 (18.05)		327 (50.00)	112 (17.15)	14 (2.14)	64 (9.79)
18	125	1 (0.80)	25 (20.00)		63 (50.40)	21 (16.80)	1 (0.80)	14 (11.20)
14 to 18	2,758	81 (2.93)	501 (18.23)		1,381 (50.07)	460 (16.68)	75 (2.71)	260 (9.43)

\*"Ideal" occlusion was reserved for those cases in which not a single maloccluded tooth could be discovered.

†"Normal" occlusion was used to designate those cases in which the number of maloccluded teeth was less than the average number (10) and the degree of displacement was so small as to catalog it clinically as "normal" and requiring no treatment. Some degree of subjectivity was necessary in such cases in order to determine whether they belonged in the category of "normal" or "mild Class I." For the most part the decisive factor was whether or not orthodontic treatment was or was not indicated.

Data for males and females were also computed separately. The findings were not significantly different.

Malocclusion was present in 78.8 per cent of the children. These children were in need of some form of orthodontic treatment. In most cases, such treatment would require simple measure. However, this aspect of the problem was not explored any further for the reasons which follow.

*Mild, Moderate, and Severe Malocclusion.*—The primary purpose of assessing the severity of the malocclusion in each child (as well as the amount) was to obtain epidemiologic data comparable to that suggested by Selare (1945) and

Moore (1948). The basis for this method was the amount of orthodontic treatment required by each individual.

It was discovered early in the course of the examinations that in our (non-orthodontic) hands, the designation of mild, moderate, and severe malocclusion, as defined in the previous section, was too subjective to be consistent or reproducible. If a more careful assessment was attempted to overcome this difficulty, the time consumed was so great as to become impractical for epidemiologic purposes. It was questionable whether the assessment could be made adequately without accurate plaster models, intraoral roentgenograms, and cephalometric headplates by any other than a well-trained clinical orthodontist. For these reasons, it was decided to abandon these data.

*Distribution of Malocclusions According to Angle's Classification.*—It became apparent during the course of the survey that the classification of malocclusions according to Angle's system also required considerable experience on the part of the examiner. Even when the examiner was carefully trained, a great deal of subjective judgment was often involved in the final decision. However, since each one of the examiners had received one year of graduate training in orthodontic diagnosis, these data were analyzed for the sake of completeness. Nonetheless, the error in assessment (particularly in Class II malocclusions) was considerable. In all cases where doubt was expressed, final judgment was made by determining the relationship of the first permanent molars.

Class I malocclusion was the most common form of malocclusion encountered. Fifty per cent of all the children were thus affected. Since 79 per cent of all the children showed some form of malocclusion, this means that 50 out of 79 (63.3 per cent) children with malocclusion were Class I (Table II). This figure compares closely with findings by previous investigators.

Class II, Division 1 malocclusion was encountered in 16.7 per cent of all the children. This type of malocclusion therefore was found in 17 out of 79 (21.5 per cent) children with malocclusion. Class II, Division 2, on the other hand, was found to affect only 2.7 out of 79 (3.4 per cent) individuals with malocclusion. These figures are very close to those obtained by other investigators, especially (Angle (1907), Korkhaus (1928), and Goldstein and Stanton (1936). Class III malocclusions were found in a higher percentage of the children studied than were found in other groups by other authors. Class III malocclusion was present in 9.4 out of 79 children with malocclusions (11.9 per cent).

*Sex Differences.*—Boys were slightly but consistently more often affected by malocclusion than girls at all age levels. The mean difference between boys and girls was 4.4 per cent. However, this difference was statistically not significant.

*Average Number of Maloccluded Teeth per Child.*—

The 2,758 children examined in this study had a total of 29,103 maloccluded teeth or an average of 10.55 maloccluded teeth per child. Boys had a slightly

greater number of maloccluded teeth than did girls (10.96 versus 10.22 maloccluded teeth per child), except at the age of 15 (Table I). The difference was statistically not significant.

The method of counting the number of maloccluded teeth in each individual was found to have a high degree of reproducibility with different examiners. It was evidently a more reliable figure than those obtained by either of the previous methods. This was apparent even in the early stages of the survey and became more evident as the examinations continued.

*Incidence of Maloccluded Teeth.*—The trend in the incidence of maloccluded teeth (as defined by the line of regression) was almost flat, increasing only very slightly with age. Therefore, there seemed to be no *significant* increase in the number of maloccluded teeth with age within this age group.

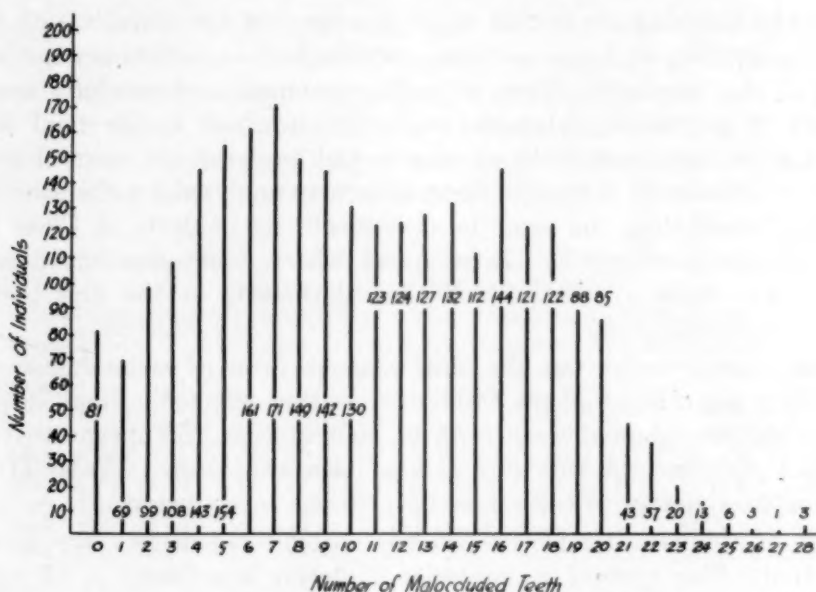


Fig. 4.—Graph showing the frequency distribution of the number of children with different numbers of maloccluded teeth (males and females combined). The distributions of males and females were essentially similar.

*Frequency Distribution of Maloccluded Teeth (Number of Persons With Different Numbers of Maloccluded Teeth).*—The distribution of individuals with different numbers of maloccluded teeth did not follow a typical “normal” distribution curve nor “peak” at a point close to the arithmetical average. The frequency was distributed fairly evenly from 0 to 20 maloccluded teeth so that the average of 10.5 maloccluded teeth had a large standard deviation ( $\pm 10$ ). The average was therefore not a good measure of central tendency since there were actually more children with 7 and with 16 maloccluded teeth than with 10 or 11 maloccluded teeth.

When the arithmetical average does not correctly define the clinical average or the most frequently encountered clinical entity, the central tendency as defined by the mode (the point at which the largest number of cases occur) is often a more useful estimate. In this series, there appeared to be a slight tendency toward bimodality at 7 and 16 maloccluded teeth that merits further in-

vestigation (Fig. 4). The number of persons with 21 to 28 maloccluded teeth (representing the very severe types of malocclusion) was very low (Fig. 4).

*Susceptibility of Individual Teeth to Malocclusion.*—The most frequently maloccluded teeth were the lower central incisors, followed by lower lateral incisors, cuspids, second premolars, first premolars, and second molars in that order.

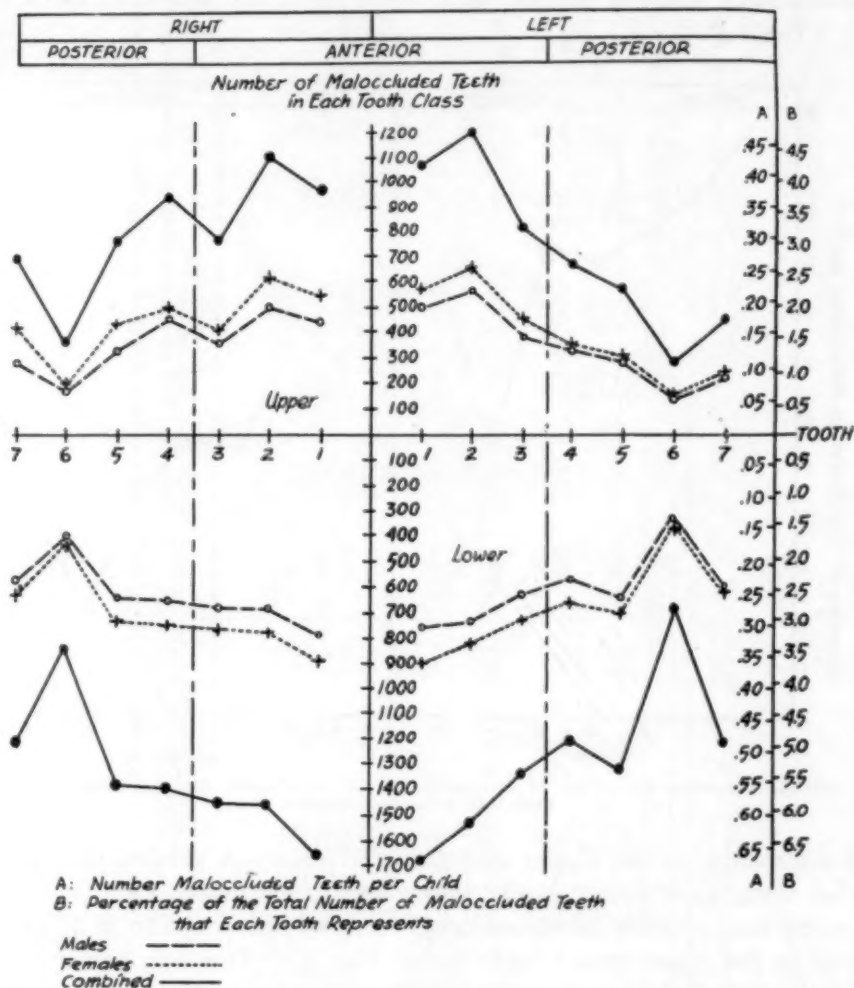


Fig. 5.—Graph showing the susceptibility of individual teeth to malocclusion. (Scale in center shows the total number of maloccluded teeth in each tooth class; scales on right show the equivalents in the average number of such maloccluded teeth per child [A] and in the percentage which each tooth contributes to the total number of maloccluded teeth [B]. The original data are listed in Table III. Data for males and females are shown separately in dotted lines).

The next most frequently maloccluded teeth were the upper lateral incisors, central incisors, and second premolars. The lower first molars were next, followed by the upper cuspids, upper second premolar, second molars, and, the least often maloccluded teeth, the upper first molars (Table III, Figs. 5 and 6). The fact that the upper first molar was least often maloccluded was undoubtedly related to the fact that this tooth was used as a point of reference for assessing the position of other teeth. There was no appreciable sex difference in the pattern of tooth susceptibility.

**Bilaterality of Malocclusion.**—Bilaterality was great but not perfect. The right side of the arch showed slight but consistently greater numbers of maloccluded teeth than did the left side (51.5 per cent versus 48.5 per cent). While the difference was statistically not significant, it was clinically apparent and might have been related to masticatory function (right-sided) or to the mechanics of examination. Possible differences between right and left sides merit further study. (Table IV.)

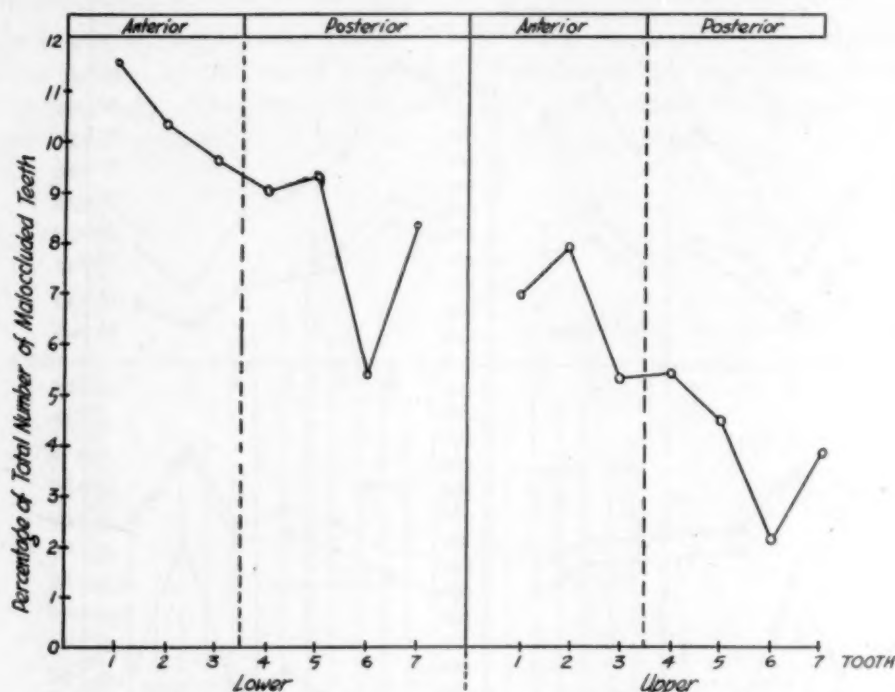


Fig. 6.—Graph showing the order of susceptibility of each tooth class to malocclusion (right and left sides combined).

**Malocclusion in the Upper and Lower Arches.**—A greater number of maloccluded teeth were found in the lower arch. The lower arch had 63.68 per cent of the total number of maloccluded teeth as contrasted to 36.32 per cent of the total in the upper arch (Table V and Fig. 5). This was probably a reflection of the fact that the *upper* first molar was used as the reference point for the assessment of the malocclusion.

**Malocclusion in Anterior and Posterior Segments.**—There was a slight but consistently greater number of maloccluded teeth in the anterior segments than in the posterior (51.79 per cent versus 48.21 per cent). This finding was consistent at all age levels and in both sexes and was statistically significant (Table VI and Fig. 5).

**Susceptibility of Individual Teeth to Loss by Extraction.**—The teeth most frequently lost by extraction were the lower first molars (42.2 per cent of the total number of teeth lost). The upper first molars were the next most susceptible (18.5 per cent), so that the four first molars accounted for 60.7 per cent of all the missing teeth (Table VII).

TABLE III. SUSCEPTIBILITY OF INDIVIDUAL TEETH TO MALOCCLUSION (MALES AND FEMALES COMBINED)

NUMBER OF MALOCCLUDED TEETH IN EACH TOOTH CLASS																
AGE IN YEARS	LEFT												TOTAL NO. OF MALOC. TEETH	NO. OF CHIL- DREN		
	RIGHT						LEFT									
14	135	59	155	214	166	222	208	225	246	171	149	116	52	88	5,845	553
15	191	79	197	230	210	300	263	284	339	221	172	151	58	111	7,783	728
16	170	70	187	222	169	272	239	260	300	177	145	135	62	131	7,048	698
17	170	117	177	217	177	262	205	235	257	195	162	146	77	89	7,038	654
18	28	21	38	44	29	57	49	53	56	42	37	29	27	23	1,389	125
Total 14-18	694	346	754	927	751	1,113	964	1,057	1,198	806	665	577	276	442	29,103	2,758
TOOTH	POSTERIOR						ANTERIOR								29,103	2,758
	7	6	5	4	3	2	1	1	2	3	4	5	6	7		
Total 14-18	1,209	841	1,380	1,402	1,456	1,474	1,671	1,690	1,539	1,353	1,226	1,340	718	1,234	29,103	2,758
18	54	35	65	67	66	64	75	81	70	61	58	67	33	60	1,389	125
17	281	226	338	339	364	358	402	405	374	331	309	336	194	295	7,038	654
16	309	196	327	329	364	374	427	419	383	322	269	314	167	309	7,048	698
15	327	214	389	373	374	389	456	462	411	371	339	354	177	341	7,783	728
14	238	170	261	294	288	289	311	323	301	268	251	269	147	229	5,845	553
	POSTERIOR						ANTERIOR						POSTERIOR			

These data were also computed separately for males and females. The differences were only slight.

These data were also computed to determine (A) the average number of each maloccluded tooth per child and (B) the percentage of the total number of maloccluded teeth that each tooth contributes as shown in Fig. 5 (right-hand scales).

TABLE IV. ANALYSIS OF THE BILATERALITY IN THE NUMBER OF MALOCCLUDED TEETH

MALOCCLUDED TEETH									
	NUMBER OF CHILDREN EXAMINED	TOTAL NO. MAL-OCCLUDED TEETH	RIGHT SIDE			LEFT SIDE			
			TOTAL NO. MAL-OCCLUDED TEETH	NO. MAL-OCCLUDED TEETH PER CHILD	PERCENT-AGE OF TOTAL	TOTAL NO. MAL-OCCLUDED TEETH	NO. MAL-OCCLUDED TEETH PER CHILD	PERCENT-AGE OF TOTAL	
BOTH ARCHES	Males and females combined	2,758	29,103	14,982	5.43	51.48	14,121	5.12	48.52
	Males	1,238	13,572	6,920	5.59	50.99	6,652	5.37	49.01
	Females	1,520	15,531	8,062	5.30	51.91	7,469	4.91	48.09
UPPER ARCH	Males and females combined	2,758	10,570	5,549	2.01	52.50	5,021	1.82	47.50
	Males	1,238	4,862	2,490	2.01	51.21	2,372	1.92	48.79
	Females	1,520	5,708	3,059	2.01	53.59	2,649	1.74	46.41
LOWER ARCH	Males and females combined	2,758	18,533	9,433	3.42	50.90	9,100	3.30	49.11
	Males	1,238	8,710	4,430	3.58	50.86	4,280	3.46	49.14
	Females	1,520	9,823	5,003	3.29	50.93	4,820	3.17	49.07

TABLE V. COMPARISON OF THE NUMBER OF MALOCCLUDED TEETH IN UPPER AND LOWER ARCHES (MALES AND FEMALES COMBINED)

AGE IN YEARS	BOTH ARCHES			UPPER ARCH			LOWER ARCH		
	NUMBER OF CHILDREN EXAMINED	TOTAL NO. MALOCCLUDED TEETH OBSERVED	NO. MALOCCLUDED TEETH PER CHILD	TOTAL NO. MALOCCLUDED TEETH OBSERVED	AVERAGE NO. MALOCCLUDED TEETH PER CHILD	PERCENT. OF TOTAL NO. OF MALOCCLUDED TEETH	TOTAL NO. MALOCCLUDED TEETH OBSERVED	AVERAGE NO. MALOCCLUDED TEETH PER CHILD	PERCENT. OF TOTAL NO. OF MALOCCLUDED TEETH
14	553	5,845	10.57	2,206	3.99	37.34	3,639	6.58	62.25
15	728	7,783	10.69	2,806	3.85	36.05	4,977	6.84	63.94
16	698	7,048	10.10	2,539	3.64	36.02	4,509	6.46	63.97
17	654	7,038	10.76	2,486	3.80	35.32	4,552	6.96	64.67
18	125	1,389	11.11	533	4.26	38.37	856	6.85	61.63
Total									
14-18	2,758	29,103	10.55	10,570	3.83	36.32	18,533	6.72	63.68

TABLE VI. COMPARISON OF THE NUMBER OF MALOCCLUDED TEETH IN ANTERIOR SEGMENTS WITH POSTERIOR SEGMENTS (MALES AND FEMALES COMBINED)

AGE IN YEARS	ANTERIOR SEGMENTS			POSTERIOR SEGMENTS		
	NUMBER OF CHILDREN EXAMINED	TOTAL NO. MALOCCLUDED TEETH OBSERVED	AVERAGE NO. MALOCCLUDED TEETH PER CHILD	TOTAL NO. MALOCCLUDED TEETH OBSERVED	AVERAGE NO. MALOCCLUDED TEETH PER CHILD	PERCENT. OF TOTAL NO. OF MALOCCLUDED TEETH
14	553	5,845	10.57	3,018	5.457	51.63
15	728	7,783	10.69	4,080	5.604	42.42
16	698	7,048	10.10	3,706	5.309	52.58
17	654	7,038	10.76	3,565	5.451	50.65
18	125	1,389	11.11	703	5.624	50.61
Total						
14-18	2,758	29,103	10.55	15,072	5.465	51.79
				14,031	5.087	48.21

The second molars, second premolars, and upper first premolars were next in the order of susceptibility to extraction with an aggregate total of 30 per cent (Table VII). The remaining 10 per cent of the missing teeth was distributed among the rest of the teeth (upper lateral incisor, upper central incisor, lower

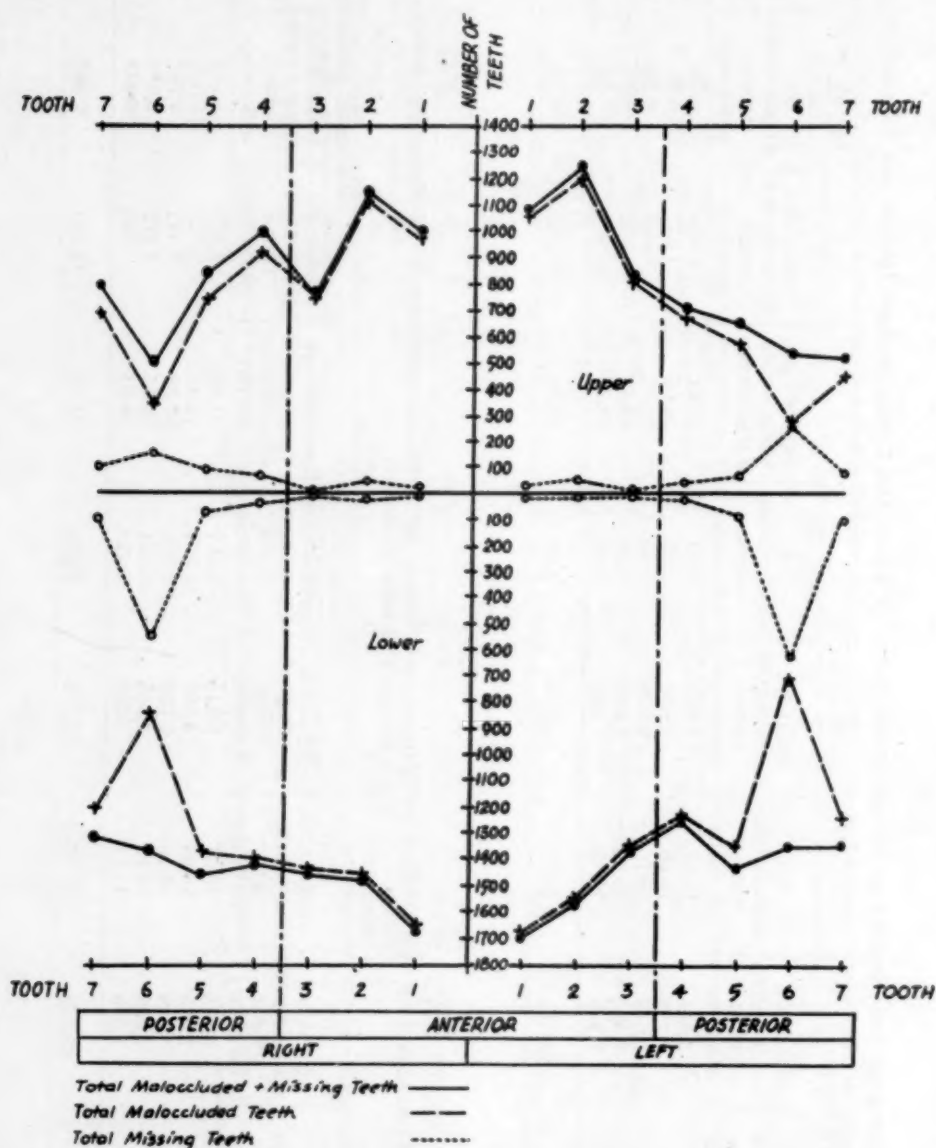


Fig. 7.—Graph showing the combined distribution of maloccluded teeth and teeth lost by extraction (males and females combined).

first premolar, upper cuspid, lower central incisor), the lower lateral incisor and cuspid being the least frequently lost (0.32 per cent). There was no significant sex difference observed in this pattern.

*Tooth Loss and Malocclusions.*—A missing tooth may be considered to be also a maloccluded tooth on the basis that it contributes nothing to a good occlu-

sion and, in fact, fosters malpositioning of the adjacent teeth. When the number of missing teeth are combined with the number of maloccluded teeth, the susceptibility of the lower first permanent molar is markedly increased (Fig. 7). The upper first molar is also affected, although to a much lesser degree, while the other teeth are not significantly altered. The combined curve shows that the *upper* first molar is still the most stable tooth in the mouth as indicated by Angle. However, the susceptibility of the lower first molar to malpositioning comes closer to the adjacent premolars and second molars (Fig. 7).

TABLE VII. ORDER OF SUSCEPTIBILITY OF TEETH LOST BY EXTRACTION IN 2,758 CHILDREN AGED 14 TO 18 YEARS

TOOTH CLASS (IN ORDER OF DECREASING SUSCEPTIBILITY)	NUMBER OF TEETH LOST BY EXTRACTION	PERCENT. OF TOTAL NUMBER (2,777) TEETH LOST
Lower first molars	1,176	42.20
Upper first molars	517	18.50
Lower second molars	219	7.84
Upper second molars	176	6.30
Lower second premolars	174	6.23
Upper second premolars	165	5.90
Upper first premolars	105	3.76
Upper lateral incisors	73	2.62
Upper central incisors	57	2.04
Lower first premolars	44	1.58
Upper cuspids	41	1.45
Lower central incisors	12	0.43
Lower lateral incisors	9	0.32
Lower cuspids	9	0.32
	2,777	99.49

#### SUMMARY AND CONCLUSIONS

The etiology and treatment of malocclusions have often been studied by clinicians; the epidemiologic aspects of the problem, only seldom. A simple quantitative method of assessing malocclusion for epidemiologic purposes is suggested. The method is based on the simple thesis of counting the number of maloccluded teeth in each individual. This study was undertaken to test the usefulness of this method and to accumulate epidemiologic data on the prevalence of malocclusion in a group of 2,758 children 14 to 18 years of age.

It was found that:

1. Almost 80 per cent of the children had malocclusions of the teeth which required correction. Only 3 per cent had "ideal" occlusion, while 18 per cent had less than 10 very mildly malposed teeth which did not require orthodontic correction ("normal" occlusion).
2. The arithmetical mean for the group was 10.5 maloccluded teeth per child with, however, a very large standard deviation ( $\pm 10$ ). Almost the same number of children showed from zero to 20 maloccluded teeth (Fig. 4).
3. There was no striking difference between boys and girls in the number of maloccluded teeth.
4. The number of persons with malocclusion and number of maloccluded teeth did not change appreciably from the fourteenth to the eighteenth year.
5. The lower incisors were the most frequently maloccluded and the upper first molars the least often affected teeth in the arches.

6. Bilateral symmetry in the number of maloccluded teeth was very frequent. Teeth in the lower jaw were more frequently maloccluded than in the upper jaw.

7. The distribution of malocclusions according to Angle's classification was consistent with other studies.

Grateful acknowledgments are made to the following persons whose cooperation made this study possible: Dr. Isaac Schour, Professor of Dental Histology, University of Illinois; W. P. MacLean, Superintendent of the Morton High School and President of Morton Junior College (Cicero, Ill.), A. R. Moore, Assistant Superintendent and Vice-President, J. Jahelka, Director of Physical Education, and Dr. M. J. Shepro, Chairman of the Committee on Health and Safety, Morton High School and Junior College.

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## PRACTICAL MANAGEMENT OF THE IMPACTED MAXILLARY CUSPID

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ONE of the most perplexing problems the dental practitioner has to face is the proper management of the impacted maxillary cuspid. There is perhaps no oral anomaly which requires greater ingenuity than the treatment of this condition. After the diagnosis of "unerupted or impacted cuspid" has been made, the immediate problem is the proper sequence necessary to visualize the tooth, or, in other words, what procedure to follow to assist in its eruption.

An approach or rationale of treatment of this condition will be presented for the edification of the general practitioner as well as the orthodontist. The actual orthodontic treatment and appliance manipulation usually needed to correct this tooth from a lingual to a normal position in the arch will also be discussed in this article.

A typical case has been selected to simplify the discussion concerning the "impacted cuspid." This case is a composite of many which have been similarly treated. Fig. 1 shows a plaster cast with the right and left maxillary deciduous cuspids in position. The patient is 14 years of age. Roentgenographic examination (Fig. 2) reveals the presence of right and left permanent maxillary impacted cuspids, both lingual to the adjacent teeth. Once the diagnosis of "unerupted or impacted cuspids" has been established, the patient is referred to an oral surgeon for surgical exposure. The oral surgeon is instructed to expose these teeth so they will erupt into the mouth. If esthetics is a factor, he is further advised to maintain the deciduous teeth in position, if at all feasible.

The oral surgeon then not only exposes these permanent cuspids, but he also removes all the overlying tissue and as much of the surrounding bony crypt as practical, i.e., without endangering the vitality of the adjacent teeth. He relieves the incisal tips if at all possible, thus channeling a path for the teeth to erupt into, and then places a surgical pack into the wound to prevent surface healing and at the same time to promote the initial movement of the teeth in the direction of least resistance, namely the channel which has been created. It will be noted that up to this point no orthodontic treatment has been attempted.

Following the necessary postoperative treatments, the patient is dismissed for three months, and observed at three-month intervals for as long as neces-

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sary. Usually cases thus handled are ready for orthodontic treatment within six months to one year. Fig. 3 shows a cast of the same patient exactly six months following surgical exposure.

The point that should be stressed here is that adequate surgical exposure has permitted these teeth to erupt without any mechanical assistance whatsoever. In this case, the six months' waiting period following surgery represents

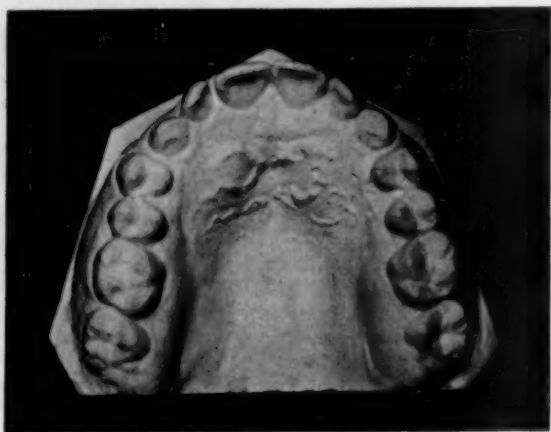


Fig. 1.

Fig. 1.—Cast showing deciduous cuspids in position.



Fig. 2.

Fig. 2.—Occlusal film showing bilateral impacted cuspids, lingual to adjacent teeth.



Fig. 3.—Same case as Fig. 1, but six months following surgical exposure of permanent cuspids.

a saving to the patient of six months of orthodontic treatment. Many ingenious appliances have been designed to bring these impacted cuspids into the mouth, when the identical results could have been obtained by proper surgical exposure and then just waiting for Mother Nature to do the rest—a great saving in time, expense, and inconvenience to the patient.

The placing of a hole in the cingulum for the cementation of a pin is a needless and destructive procedure. Many cuspids have lost their vitality through accidental exposure of the pulp while drilling for a pinhole in a bloody field. Likewise, the placing of onlays to hasten eruption is usually not only unnecessary, but it needlessly adds orthodontic treatment time to the case at hand. These two methods are rarely, if ever, justified without first exposing surgically and giving the tooth a chance to erupt of its own accord. They should be used only as a last resort.

#### ETIOLOGY

The etiology of impacted teeth has long been a controversial subject. Several theories have been advanced as to the underlying cause of the impacted cuspid.

The presence of supernumerary teeth may be considered an etiological factor. However, the presence of a supernumerary tooth in the upper cuspid area is so rare that this cause alone cannot be considered as having great importance.

At the age of 2½, the first premolar germ is above the deciduous first molar, but already the germ of the cuspid is lying *above* the premolar germ. Perhaps this position of the cuspid above all the other permanent teeth helps explain why this tooth is so frequently impacted. From this position it has a long and devious way to go. It must erupt mesially and occlusally, notwithstanding the fact that most of the other teeth chronologically precede the cuspid in eruption time. Therefore it must assume its place in an arch where all of the other teeth have more or less assumed their respective places and the cuspid, so to speak, must accept whatever space is left over.

As early as the age of six the tip of the permanent cuspid may normally be seen erupting lingually to the apex of the deciduous cuspid. When for some reason the resorptive forces do not attack the deciduous cuspid root, this may cause the permanent cuspid to become impacted. Another way of saying the same thing is that the delayed exfoliation of the deciduous cuspid is an etiologic factor in the production of this condition. This deflects the permanent cuspid and prevents it from erupting. Since these impacted cuspids are practically always deflected lingually, it is entirely possible that the normal eruption of the impacted cuspid may be retarded because of the character and density of the palatal tissue. This lingual tissue is much firmer and more fibrous than the tissue on the labial side; it serves as an obstacle to normal eruption, and produces an impaction.

Several cases have been reported in which one parent and at least one or more progeny revealed the presence of an impacted cuspid. There is also substantial clinical evidence to support the contention that unerupted cuspids may be congenital in nature.

Dewel stated that "curiously, unerupted cuspids frequently occur in quite normal arch form cases. Therefore the cause is usually not due to crowded or contracted arches."<sup>1</sup> Actual clinical material has substantiated this statement.

## DIAGNOSIS

The maxillary permanent cuspid shows first evidence of calcification at 4 to 5 months of age; the crown is completed at 6 to 7 years of age and the usual eruption time is 11 to 13 years of age. Therefore, when this tooth fails to make an appearance by 13 years of age, one should immediately be suspicious of an impacted or unerupted cuspid.

Before any positive diagnosis can be made, a roentgenographic examination is imperative. The usual intraoral examination will suffice for most cases. An occlusal film may be employed in addition to the intraoral study to localize further the unerupted tooth or teeth. (See Fig. 2.)

By applying Clark's principle of localization, one may determine at a glance whether the unerupted tooth is buccal or lingual. If two separate exposures of the same area of the mouth are taken with the x-ray tube being moved mesially or distally, and the unerupted tooth moves in the same direction as the tube is moved, then this tooth is lingual to the roots of the adjacent teeth. On the other hand, if it moves in the opposite direction to the tube, the tooth is buccal. This briefly is Clark's principle of localizing an unerupted tooth. The following x-ray films will illustrate the point. Fig. 4 shows an unerupted cuspid. In Fig. 5 the tube has been moved mesially as evidenced by the appearance of the central incisor of the opposite side. In Fig. 4 the tip of the cuspid just overlaps the central incisor, but in Fig. 5 the tip of the cuspid is mesial to the central incisor and nearly touching the opposite central incisor; therefore the unerupted tooth has moved mesially or with the tube and is lingual to the adjacent teeth.

Fig. 6 shows another unerupted cuspid, and Fig. 7, taken with the tube moved mesially, shows that the tooth in question has moved *opposite* to the x-ray tube or distally. Therefore the unerupted tooth is buccal to the adjacent teeth.

Figs. 8 and 9 bring out a very interesting point in angulation. Both views of an unerupted cuspid were taken of the same patient within one minute of each other. In Fig. 8, the permanent cuspid seems practically horizontal and situated at the apices of the teeth in the buccal segment. At first glance, the prognosis for the ultimate eruption of this tooth would be hopeless. In Fig. 9 the condition is seen in an entirely different light. The unerupted cuspid no longer appears horizontal, but rather seems inclined toward the mesial, which is a truer picture of the existing condition. This dramatically illustrates the importance of accurate record making, in addition to making occlusal films and even stereoroentgenograms, to determine the true positions of these teeth.

Broadbent<sup>2</sup> demonstrated by taking a series of anteroposterior and lateral headplates of children, starting at the age of 6, and at intervals of three to six months thereafter, that it is possible to observe with great accuracy the path of the permanent canine as it proceeds along its devious course of eruption. By noting deviations from normal he can predict when the permanent maxillary canine is being deflected lingually long before its normal eruption time. As soon as this condition is detected, Broadbent removes the offending tooth, the



Fig. 4.



Fig. 5.

Fig. 4.—Impacted maxillary cuspid.

Fig. 5.—Same tooth as Fig. 4, but with x-ray tube moved mesially. The impacted tooth moved mesially too, and is therefore lingual to adjacent teeth.



Fig. 6.

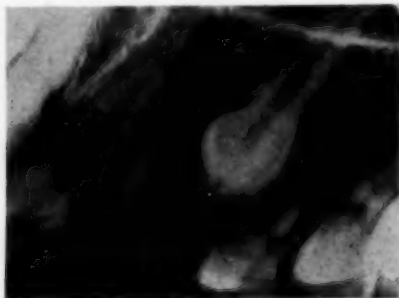


Fig. 7.

Fig. 6.—Impacted maxillary cuspid.

Fig. 7.—Same tooth as Fig. 6, but with x-ray tube moved mesially. The impacted tooth moved distally, and is therefore buccal to adjacent teeth.

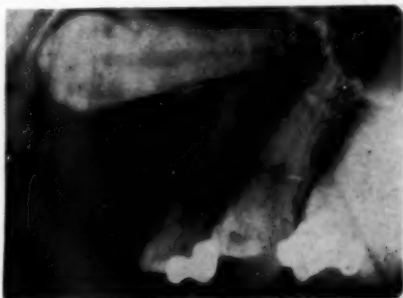


Fig. 8.



Fig. 9.

Fig. 8.—Impacted cuspid seems horizontal and in a hopeless position.

Fig. 9.—Same tooth as Fig. 8, but taken from a different angle.

deciduous canine, so that the permanent canine may assume its normal position and thus not be deflected lingually into the dense fibrous tissue of the palate.

#### FREQUENCY

"The upper cuspid is second only to the lower third molar in order of frequency of impaction."<sup>3</sup>

"Impacted upper cuspids occur more frequently in females than in males, are rarely congenitally missing, occur much more frequently in the upper than in the lower jaw. Also when impacted and unerupted, these teeth occur practically always lingual, rather than buccal to the adjacent teeth in the arch. It is extremely rare for a deciduous cuspid to be impacted."<sup>4</sup>

#### NEED FOR EXPOSURE

Sometimes in later life, these unerupted teeth may start to move in the direction the crown is facing. Since the crown is nearly always pointing to the mesial, there is a distinct danger to the roots of the lateral and central incisors. The pressure thus produced may cause resorption of the central and lateral roots and subsequent devitalization of these teeth. Another common condition observed is the displacement of the lateral incisors due to pressure from the cuspid crown.



Fig. 10.—Destruction and loss of permanent lateral incisor by an ectopically erupting cuspid.

Frequently the membrane surrounding the crown of an unerupted tooth becomes cystic and may lead to extensive destruction of bone. Should these cystic areas become infected, they may be considered causative factors in producing local or referred pain.

In rare cases, the pressure produced by a misplaced cuspid may cause destruction of a tooth in its path. Fig. 10 shows complete destruction and subsequent loss of a permanent lateral incisor by an ectopically positioned cuspid.

#### SURGICAL REQUIREMENTS

After the need for surgical exposure has been determined, the patient should be assured that the operation, while quite simple, takes considerable time to perform. The exact position of the unerupted tooth or teeth should be ascertained by taking x-rays from several angles and applying Clark's prin-

ciple of tooth localization. Since practically all cuspids requiring surgical exposure are lingual, the technique<sup>5</sup> for exposing a lingually impacted cuspid will be described:

1. Anesthesia is obtained by infiltration in the mucobuccal sulcus and by blocking the nasopalatine nerve and the anterior palatine nerve on the side to be exposed.

2. The palatal mucoperiosteum is reflected at the site of the unerupted crown. This is accomplished by incising the interproximal papillae on the lingual surface and carrying the incision through the adjacent gingival crevice. This incision is extended for sufficient length to permit adequate exposure of the bone over the coronal part of the unerupted tooth. The mucoperiosteum is reflected from the lingual embrasures of the teeth.



Fig. 11.—View immediately following surgical exposure of maxillary cuspids.

3. By means of hand chisels and small surgical burs, the overlying bone is removed and the crown is exposed. A small surgical bur is used to cut a definite pericoronal space, being sure the entire crown including the tip is exposed. Extensive removal of bone is done if possible, to permit the desired movement of the crown. Great care is taken to be sure adjacent teeth are not injured or their radicular parts exposed.

4. The mucoperiosteal flap is replaced and with small scissors and knife a window is cut in the flap to expose the crown of the tooth into the mouth. This window may necessarily include the gingival crest.

5. The margins of the flap are retained by sutures from palatal to labial mucosa.

6. A zinc oxide-eugenol type of cement is incorporated in a  $\frac{1}{4}$  inch strip of gauze. (Some men prefer the use of baseplate gutta-percha.) This strip is then carefully packed into the pericoronal space and the remaining portion used to cover the operative defect completely.

7. The pack is left in place until epithelization of the margins of the wound takes place—usually ten to fourteen days. The wound is inspected at this time. A loose similar pack is replaced if repair is not adequate. Too early removal of the dressing may result in granulation over the wound before the tooth has shifted close enough to the surface to prevent closure of the defect.

## ACTUAL ORTHODONTIC TREATMENT

After the exposed cuspid has attained its maximum eruption (usually three months to one year following surgery), an appliance is prepared that will produce a labial force on this tooth. Of course if other orthodontic requirements are to be met, such as creating space for the cuspid, common sense would dictate completing these while waiting for the cuspid to erupt. The mechanics for moving the cuspid are then integrated into the over-all requirements of the case. It should be borne in mind, however, that while the tip of the cuspid crown is adjacent to the central or lateral roots, extreme care should be exercised in moving the central or lateral incisors because of the likelihood of damaging their roots while the cuspid crown is in the way.

The actual appliance used is left to the discretion of the operator. It is felt though, that the use of the removable Mereshon type lingual wire, fitting into  $\frac{1}{2}$  round tubes soldered on molar bands, merits consideration. Since the lingually locked cuspid occurs so often in cases of normal arch and jaw relationship, the lingual appliance is usually preferred because of the ease with which it is constructed and the simplicity of its adjustment. After obtaining adequate separation of the molar teeth, bands are made. With the bands on the teeth, a compound impression of the upper jaw is taken, the bands are inserted into the impression, sealed to place, and a plaster or stone model is poured. When the model has been separated,  $\frac{1}{2}$  round tubes are soldered onto the lingual surfaces of the molar bands. Wire 0.038 inch in diameter is now closely adapted to the model, following the configuration of the lingually locked teeth. In addition, small safety pin springs, 0.022 inch in diameter, are soldered to the arch wire opposite the cuspid teeth. Tubes are soldered on the buccal surfaces of the molar bands in case they are needed later. The appliance is now cemented to position.

It should be noted that no attempt is made to prevent the lingually erupting teeth from attaining their maximum eruption in a lingually locked position. It is felt that when the time comes to correct these teeth from a lingual position to the normal relationship, buccal to the lower teeth, a better mechanical leverage is obtained if the teeth are permitted to attain their maximum eruption. However, it is imperative in most cases at this time to place a bite block (Fig. 13) on the lower teeth which will hold the upper and lower teeth apart while the cuspids move from a lingual to a buccal relationship with the lower teeth. Otherwise it is very time consuming to depress the canine sufficiently to jump the bite. The actual tipping of the cuspid teeth is now obtained by adjusting the safety pin springs.

The maxillary cuspid being a long and cone-shaped tooth makes it exceedingly difficult to form a band that will stay in place. Should it be found necessary to make an attachment for this tooth, the following technique of making a cast band will prove very helpful:

Select a copper band 36 gauge by  $\frac{1}{2}$  inch; festoon the mesial and distal aspects and take a compound impression of the tooth. Wrap Scotch tape around this impression. Pour a model using a good casting investment and

when hard, separate the model from the impression. Now pencil an outline of the band on the model, adapt 28 gauge pink wax to model, being very careful not to exceed penciled outline. Secure wax in four places, two buccal and two lingual. Using a piece of wire about 0.055 inch for a sprue, heat and fasten this wire at right angles to the lingual surface of the tooth. With a bit of wax, reinforce the point at which the sprue meets the wax. Invest and cast, using a good, hard casting gold. With a carborundum stone, machine the inside of the band generously. Solder necessary attachments to this band, and cement to position.

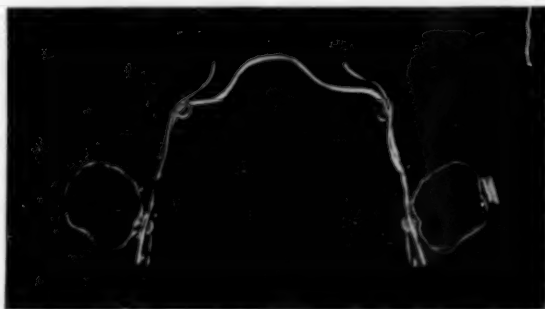


Fig. 12.—Mershon type removable lingual appliance showing springs for moving cuspids labially.

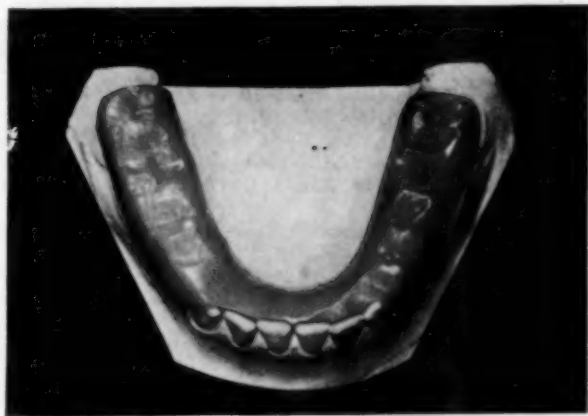


Fig. 13.—Lower acrylic bite block.

#### SUMMARY AND CONCLUSIONS

As a summary, the following points are noteworthy:

1. Adequate surgical exposure is the first step in the management of an impacted cuspid.
2. A waiting period of three to twelve months is routine procedure following surgical exposure.
3. Orthodontic intervention is rarely justified or necessary, if the impacted tooth has been adequately exposed.
4. The delayed exfoliation of the deciduous cuspid is probably the principal etiological factor in the production of maxillary cuspid impactions.

5. Cuspid impactions are congenital in nature.
6. When a maxillary cuspid impaction occurs, it is practically always lingual to the adjacent teeth in the arch.
7. Because of possible injury to adjacent teeth and supporting structures, impacted cuspids discovered in later life should be closely watched and considered candidates for removal if surgical exposure is not practical.
8. It is entirely possible that the increased popularity of cephalometric x-rays, taken in lateral and anteroposterior views as a routine diagnostic orthodontic procedure, will detect impactions in their incipency.
9. By detecting an impaction early and removing the offending tooth, the deciduous cuspid, it may be possible to prevent this condition from occurring in a great many cases.

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## CHROME ALLOY IN ORTHODONTICS

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### HISTORY

**M**ODERN corrosion resistant steels owe their conception to at least three principal sources: (1) Harry Brearley, Sheffield, England, (2) Elwood Haynes, Indianapolis, Ind., and (3) Dr. Benno Strauss and Dr. Maurer, Essen, Germany. Even though the discoveries of these men followed along the same general lines and were made at approximately the same time, it seems quite evident that they were completely independent of each other.

Although credit for the exploitation of these alloys is generally conceded to the above-mentioned men, actually, considerable preparatory work had been done by innumerable metallurgists before their days, chromium steel, made in the crucible, having been commercial since 1869 when Julius Baur established the Chrome Steel Works in Brooklyn. Nickel steels and the chromium nickel steels, with a few per cent of alloy, had been well known during the last century to naval ordnance manufacturers, and prior to the first World War the information was gradually extended to general use through the budding automobile industry, so, obviously, the men mentioned started from positions well prepared by the pioneers. This, of course, in no way detracts from their achievements, as it is often true that the value of a pure discovery lies in its adaptation to general use.

Brearley, who was chief of the research laboratory run jointly by Messrs. John Brown & Company, Ltd., and Messrs. Thomas Firth & Sons, Ltd., in Sheffield, England, was engaged about 1913 in research to find an erosion resistant metal for use for rifles and naval guns. One of his many experiments produced an alloy of steel with a high chromium content, without nickel. The first practical use of this alloy was made about 1914 when some knives were made up out of the material by Messrs. R. F. Mosley of Sheffield. No application for British patent was made, but in August, 1915, patents were granted in Canada, and in September, 1916, another patent was granted in the United States.

Elwood Haynes, according to an account of his experiments published in 1919,<sup>1</sup> did considerable experimenting around 1911 or 1912 with cobalt, chromium, iron alloys, and a little later with some iron chromium alloys without cobalt, running probably 9 per cent to 20 per cent chromium. He was interested principally in the alloys as cutting tools and not particularly in their corrosion resistance.

It is interesting to note that he says his first application for a patent was rejected on the grounds chromium steels were not new. However, he says that letters were written to practically all the large steel producers in the United

States asking for "nonrusting" or "nontarnishing" iron or steel, but the replies received were all of negative character and show that no such alloy existed, but suggested the possible use of alloys of nickel and iron. It is quite clear, therefore, that steel makers in the United States as a whole, and probably those of other countries as well, were in ignorance of the special nonrusting characteristics of high chromium steels. This is important, as attempts have been made to suggest that such a characteristic of high chromium steel was well known.

Haynes filed his second application for patent in 1915, actually fifteen days before Brearley filed his. Haynes's patent, however, was not granted until 1919.<sup>2</sup>

The third set of early experiments with stainless steel were conducted by Drs. Strauss and Maurer of the Research Department of Messrs. F. Krupp, A. G., who had become interested in the joint effects of chromium and nickel on steel. In June, 1914, Dr. Strauss made a preliminary report on their investigations in a paper read before a meeting of chemists at Bonn. The paper dealt principally with the marked rustlessness and acid-resisting properties of steel containing large amounts of chromium and nickel. They obtained patents in October, 1912, for two series of chrome nickel alloys, the first series containing about 0.5 to 20 per cent nickel, together with 7 per cent to 25 per cent chrome. The second series contained 4 per cent to 20 per cent nickel, with 15 per cent to 40 per cent chrome. In both series, the carbon content was limited to 1 per cent or less. It will be noted from this that these men were principally interested in chrome nickel steels and were not aware of the excellent properties of the pure chromium steels.<sup>3</sup>

In regard to steel containing only chromium, although its property of resistance to corrosion was discovered almost simultaneously by Brearley and Haynes, it is to Brearley almost entirely that the adaptation to engineering and technical purposes is due. It can be said quite definitely that the type of stainless steel which depends for its properties on the presence of chromium alone had its commercial birth in Sheffield, and was largely reared there. On the other hand, the credit for the chrome nickel type of stainless steel, particularly where the nickel content is high enough to produce what is known as austenitic alloy, is due to Drs. Strauss and Maurer. Articles made from this alloy were exhibited by Messrs. F. Krupp at the Malmo exhibition in April, 1914, and were probably among the earliest rust-resisting steel articles made.

The commercial development of stainless steels in this country was limited almost entirely, for the first eight or ten years, to the plain chromium steels of the Brearley type—the austenitic chromium nickel form not being introduced here until the end of 1923. In Germany, of course, this latter steel had been employed earlier, but, due to wartime conditions, it is doubtful whether it was used to any great extent in that country prior to 1919 and 1920. Incidentally, the development of this type of steel was made even later in the United States than it was in England.<sup>4</sup> Apropos of this, it is interesting to note that Dr. J. A. Matthews, of the Crucible Steel Company of America, stated in the discussion of Haynes's paper in 1921, "We pride ourselves on being a progressive people, but in the matter of adopting stainless steel for general use, we are far behind

our conservative British cousins. The use of stainless steel in Great Britain, in its various applications, has gone ahead very much more rapidly than it has in America."<sup>5</sup>

Although the term "corrosion-resistant steels" would probably be a better name for these materials, the popularity of the word "stainless," as applied to them, is such that it is almost universally applied to all the alloys of iron and chromium, or iron, chromium, and nickel. Actually, few of these alloys are really stainless, and many of them are not steels in the sense that they do not harden very much in quenching.<sup>6</sup>

As stated in the previous paragraph, when we speak of "stainless steel" we are not speaking of any one metal or particular alloy, but are, in effect, referring to a series of alloys whose physical properties vary tremendously. In fact, there are approximately 30 of these primary alloys whose types have been standardized by the industry, and each of which has distinctive characteristics which govern its application and use. These types are numbered for proper reference, and divide the group into two main subgroups. Those alloys beginning with the number 3 contain nickel, in combination with chromium, whereas those beginning with the number 4 are nickel free, or in one or two cases, contain very minute quantities of this material.<sup>7</sup>

The whole series of stainless steels is also divided into three principal divisions, primarily for the purpose of description. They are:

1. Alloys of iron, chromium, and carbon wherein the carbon range may be approximately 0.10 to 1.2 per cent with accompanying chrome ranges of 12 to 17 per cent and are generally known as the martensitic group. Alloys within this group are capable of heat treatment like ordinary high carbon steel and the greatest degree of corrosion resistance is possible in that condition.

2. Alloys of iron and substantial amounts of chrome range from 15 to 27 per cent wherein the carbon is of no particular significance other than being residual. This group is known as the rustless or ferretic classification and its corrosion resistance is due to the inherent composition, rather than being dependent on subsequent heat treatment as in the case of group 1.

3. Alloys of iron plus substantial amounts of chrome and nickel wherein the chrome range may be 15 to 25 per cent, with nickel 8 to 20 per cent. These are the so-called stainless alloys and have the highest degree of corrosion resistance of the three classifications. Because of a difference in metallurgical character as compared to the other two, they are commonly known as the austenitic classification. Again, their corrosion resistance is due to inherent composition and does not depend on a heat treatment of the type mentioned for group 1.<sup>8</sup>

The material in which we are primarily interested in orthodontics is type 302, which contains (in addition to the main iron content) the following chemicals: carbon, 0.08 per cent to 2 per cent; manganese, 0.02 per cent maximum; silicon, 0.01 per cent maximum; phosphorus, 0.04 per cent maximum; sulfur, 0.03 per cent maximum; chromium, 17 per cent to 19 per cent; and nickel, 8 to 10 per cent. Another alloy which is very similar to this, and has almost

identical physical properties, is type 304, the main difference between the two being that 304 contains only 0.08 per cent carbon maximum, and from 18 per cent to 20 per cent chromium and 8 per cent to 11 per cent nickel.

These alloys are austenitic, very high in corrosion resistance, nonmagnetic when annealed, but slightly magnetic when cold worked. They are not susceptible to heat treatment but may be cold worked to very high tensile strength.<sup>9</sup>

#### ORTHODONTIC HISTORY

Stainless steel, or, as it is now more generally called especially regarding orthodontic application, "chrome alloy," has numerous desirable qualities that have been recognized from the very beginning. Its hardness, its high tensile strength, even in small wires, and especially its extreme resistance to corrosion and discoloration have had a great deal to do with its adoption as an orthodontic appliance material. However great these beneficial effects may be, their utilization was almost abandoned in the early days because of the extreme difficulty in manipulating and fabricating the various parts into a whole. This difficulty revolved itself around the seemingly impossible task of joining the various pieces together, the usual fluxes and solders not being adequate.

Stainless steel first made its appearance in the orthodontic field around 1929 or 1930, at which time the Renfert Company was attempting to interest orthodontists around the country in wires of the metal, made by the Krupp Company of Germany. Quite a few men attempted to make use of the material but most of them (including me) abandoned their attempts as unsatisfactory and seemingly impossible. However, a few, notable among them, L. T. Walsh, of Pueblo, Colo., A. B. Brusse and J. L. Carman, of Denver, W. B. Stevenson, of Amarillo, Texas, and B. Bell, of Dallas, held strongly to their faith in the material because of their realization that the qualities inherent in it would materially advance the mechanical application of orthodontic treatment. Their experiments were continued in the hope of finding an efficient solder or flux that would act as the key to unlock the difficulty of fabrication. Innumerable flux formulas and untold soldering techniques were tried, but progress was extremely slow. It was found that excellent-appearing unions of wires by soldering were possible, but that after two to ten weeks in the mouth, the joints discolored and broke apart. At about this time, the material known as U.S.S. 18-8 was settled upon as the most advantageous of the various types of stainless steel and some progress was made regarding its application. However, soldered joints continued to break down and it seemed as if the problem were insoluble.

Walsh stated that spot welding was first taken up by them in November, 1933.<sup>10</sup> However, this date is probably a little late, as Brusse and Carman referred to their spot welding in a clinic given at the meeting of the American Society of Orthodontists in November, 1933. It is rather difficult to substantiate the definite time when spot welding appeared as the solution to the problem of fabrication of chrome alloy. It is known, for instance, that W. B. Stevenson, of Amarillo, Texas, purchased and used a rather cumbersome spot welder as early as the latter part of 1931. It is interesting to note that again, as pointed out in the first part of this paper, Europe was ahead of the United States in

working with the stainless steels, deCoster,<sup>11</sup> of Brussels, when presenting a demonstration at the Second International Orthodontic Congress in London, in July, 1931, on the use of stainless steel, making the comment that "the greatest progress in the use of rustless steel has been the use of electric welding for the assemblage of the various appliances." However, as far as soldering the material is concerned, the Europeans were probably having the same difficulty that we were. At this same meeting of the International Congress in London, July, 1931, Dr. Paul Simon,<sup>12</sup> of Berlin, presented a paper in which he spoke of soldering the material with soft solder, such as tin solder.

During the time that one group of men were working diligently to perfect the technique of spot welding, there was another, smaller group, including Ed Arnold, of Houston, Brooks Bell, of Dallas, and Orin McCarty, of Tulsa, who were working just as diligently to perfect the technique of soldering.

Probably the first real presentation of significance in this country on the use of stainless steel in orthodontics was given at the meeting of the American Society of Orthodontists in Oklahoma City, November, 1933. At this meeting, Drs. Brusse and Carman<sup>13</sup> presented their paper on "Chrome Alloy," and a group clinic, "Technique of Handling Chrome Alloy Material," was presented by Brooks Bell, E. B. Arnold, F. H. Harris, W. B. Stevenson, C. B. Cunningham, and O. H. McCarty. At this same meeting, Dr. Frank M. Casto, Cleveland, Ohio, who had been working independently on the subject, also presented a clinic entitled "Stainless Steel in Orthodontia." These clinics and papers drew large and interested attendance and whetted the appetite of the members for more. In connection with this is the editorial comment<sup>14</sup> of the JOURNAL on the meeting to the effect that "of especial interest were the clinics and demonstrations on the use of chrome alloy—and the apparent success some members are having with the use of chrome alloy." Members of the Southwestern Society and the Rocky Mountain Society especially showed great interest in the subject, probably due to the fact that a great deal of this pioneer work was being done by their confreres in these areas. At any rate, the use of the material showed considerably more progress and application in the southwestern section of the country than it did in other sections.

Even though a great deal of interest developed from this meeting and the scope of the experiments was considerably widened, the material still resisted practical methods of fabrication and utilization. Soldered joints continued to break down and auxiliary springs to fall off, and although spot-welded joints seemed to be excellent, the cost of the equipment and its extreme bulkiness and awkwardness prevented its general adoption.

Some appreciation of the difficulty involved in joining the various pieces of chrome alloy together can be gained from the fact that some men even attempted to make folded, pressed joints, very similar to those employed by sheet metal workers in making interlocking sheets of galvanized iron. Prof. Dr. Paul W. Simon, of Berlin, Germany, presented a technique of this type before the European Orthodontological Society, Scheveningen, Holland, in May, 1934.<sup>15</sup>

Real progress in the use of chrome alloy came with the announcement of a spot welder made especially for orthodontic use. This was in 1934, and in

1936 a much smaller, more efficient, and more convenient machine was put on the market by the same company. This company (Rocky Mountain Metal Products Company) was incorporated in 1934, and, though a commercial institution, its attitude toward the profession has been such that it is due considerable credit for perfecting the technique and use of chrome alloy in orthodontics.

Although welding had proved itself as a suitable method of fabrication, there were those who felt that soldering still had a definite place in the technique. Experiments continued along this line and, with the use of better fluxes and solders, definite progress became evident. In December, 1934, Bell<sup>16</sup> presented a paper before the Asociacion Mexicana de Orthodoncia, in which he demonstrated his soldering technique and showed that it had proved successful in his practice and in the practice of others who were using it.

In any type of experimental work, there is always a diversity of opinion, and the work being done with chrome alloy was no exception. In "The Forum" of the April, 1936, issue of the JOURNAL, page 431, Dr. Brusse stated, "I am convinced that the soldering of stainless steel is a failure, chiefly because we cannot depend upon the permanency of the soldered joints. Therefore, we must resort to spot welding," and in the January, 1937, issue of the JOURNAL, page 45, Dr. T. W. Sorrels stated, "In my opinion, the spot welding machines will soon find a resting place on the shelves of the users, for a return to the easier method and wider range offered by soldering." As is usual in such a diversity of opinion, the actual truth of the matter is somewhere in between. Actually, the fabrication of chrome alloy orthodontic appliances is most efficiently and conveniently accomplished today by the application of both spot welding and soldering. From the time of the realization of this fact, the technique has advanced and expanded, has become quite definite in its application, and is generally employed by quite a large number of practicing orthodontists today. It is a definitely proved technique and material, offering many advantages over other materials.

#### CHROME ALLOY IN ORTHODONTICS

Even though the term "chrome alloy" is not an accurately descriptive term, its use has become so universal that it will be used throughout this paper with the understanding that the alloy which is being discussed is an 18-8 stabilized chrome nickel steel of the type number 302 or 304, as standardized by the American Iron and Steel Institute. This material has numerous very distinct characteristics that other alloys do not possess, and which are of very definite benefit in orthodontics. However, to get the most out of the material, and to take advantage of its unique characteristics, it is necessary that specific techniques be employed, which are at times at variance with the technique of the use of other materials. Attention will be called to these unique characteristics as their properties arise in the explanation of the chrome alloy technique.

It is not within the scope of this paper to discuss the advantages or disadvantages of any certain type of appliance. Neither is it the intent to show the benefits of one material over another, but rather to explain the technique of the use of stainless steel in orthodontic appliance construction. It is inevitable,

of course, that comparisons may be drawn between so-called chrome alloy and the precious metal alloys, but this is done only to clarify the differences in technique and to give those who have been employing the precious metal alloys a pertinent standard of relationship.

Chrome alloy may be used for any type of appliance in orthodontics today. Anterior and posterior attachments are available for the application of any theory of treatment, and accessory attachments are limited only by the ingenuity of the technician. There are, at the present time, some 15 to 20 various types of anterior attachments available on the market and 12 to 15 methods of posterior attachments. Appliance construction may be either direct in the mouth, or indirect on models, as the operator may desire. In the adoption of chrome alloy for orthodontics, cognizance should be taken of the following observations:

1. Temper lost through overheating is not capable of being successfully restored; however, employment of a proper technique will avoid this difficulty.

2. The tensile strength of the material is so much higher than that of the other materials generally employed that wires of considerably smaller size are indicated to produce the same pressures.

3. Although this high tensile strength is a retardant to breakage in the mouth, it increases the possibility of fracture in fabrication, especially at the point of sharp bends. This is easily avoided by making these bends slowly. A piece of high tensile stainless steel wire, bent at a 90 degree angle, is much more likely to fracture if bent quickly than if it is bent slowly to the same angle. Sharp bends of more than 90 degrees require that the area of the bend be heated to a dark red before completing the bend past the 90 degree point.

#### WELDING

Spot welding (form of electrical resistance welding) is accomplished by holding the pieces to be welded together between hard copper electrodes under pressure and passing a high-amperage current through them for a definite period of time. The electrical resistance of the material is such that quite high temperatures are generated at the surfaces in contact, thereby causing fusion of the materials while the pressure completes the weld. Chrome alloy is especially suitable to resistance welding because its electrical resistance is high, about six times that of ordinary mild steel, the thermal conductivity is quite low, thereby restricting the flow of heat to the immediate point of welding, and, since the melting point is lower even than mild carbon steels, less current is required. The heat is generated rapidly and held localized at the point generated. In fact, a manual on the fabrication of stainless steel says, "Spot welding of U.S.S. 18-8 and similar stainless steels is a simple and highly efficient means of making joints, especially with light gage material, whether in the annealed or the cold rolled high-tensiled condition; and, in fact, it is the only method of making satisfactory joints that maintain the high tensiled characteristics of the high tensiled materials."<sup>17</sup>

There are three prime requirements for spot welding: (1) pressure, (2) current, and (3) time. These three must be so correlated that the passage of

current through the metal must be for the exact length of time (a fraction of a second) that the material becomes fused, and the pressure between the electrodes holds the fused metal together until it hardens (a very minute fraction of a second). For these reasons, pressure adjustments between the electrodes must always be correct, though considerable leeway is allowable, electrodes must be kept clean and bright to facilitate passage of the current, and proper line voltage must be brought to the machine so that enough current is available to complete the fusion.

Several types of welders for orthodontic use are on the market today. Comments, however, will be restricted to that manufactured by the Rocky Mountain Metal Products Company, not because it may or may not be any better than any of the others, but for the simple reason that this is the one with which I am thoroughly familiar. There are two main types, one in which the time of current exposure is by manual switch, and one in which exposure is obtained automatically at the user's discretion. The manual control machine is excellent; however, it does require some experience to give just exactly the right amount of current to make a complete weld and still not burn the material. This danger is eliminated in the automatic switch model because the operator selects the time exposure that he desires and the switch automatically makes that exposure every time. Consequently, all welds are perfect and are absolutely uniform.

The welder is furnished with a dial running from one to five for setting the current intensity desired, as thicker metals will require more current than thinner pieces. On the right of the top of the welder is the dial time switch running from 1 to 10, and it is dialed exactly as a telephone is dialed. This switch is so designed that each number dialed will give the corresponding number of short exposures, thereby allowing the metal to cool between each current application. In other words, if the number of 3 is dialed, there will be three short, quick pulsations of current. If 4 is dialed, there will be four pulsations, etc. Due to the difference in line voltage in different offices, and the difference in electrode size and position as used by different men, it is difficult to set up any definite standards of current and time exposure that will always be correct; however, a short series of experiments with the machine will soon give the information necessary to complete perfect welds. Small currents used for a long time dissipate the heat through conduction and radiation and welding does not take place. On the other hand, too great current, even for a short period of time, will fuse or burn the exterior surface. The correct time and current will have to be determined by trial and test of the weld. Judgment by visual appearance of a weld spot comes only with time and experience; however, a properly made weld should allow the materials to be twisted in their own plane at least 60 to 90 degrees before breaking.

There are numerous ways of approximating the electrodes for welding of different sizes and shapes; however, I have found the following electrode arrangement suitable for practically all orthodontic welding, and it does not require the usual change of arrangement for various shapes and sizes of materials. The top electrode is conical in shape, with the point of the cone cut

off to give a flat about 1 mm. in diameter. The lower electrode is perfectly cylindrical in shape, lies in a horizontal plane, with the upper electrode point touching it at the extreme end. With this arrangement, it is possible to weld band material, hooks, brackets, flange tubes, wires, or any other shape, even to the extent that the smallest anterior bands can be slipped over the lower electrode for welding of attachments. Pressure between the electrodes is obtained by loosening the upper electrode, pulling the lower one down about  $\frac{1}{8}$  inch, allowing the upper one to come down with it, and then tightening the upper electrode in this position.

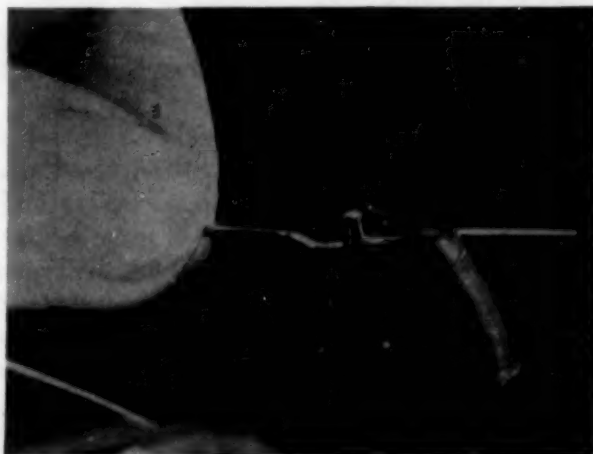


Fig. 1.

Furnished with each welder is an annealing fork, and a pair of annealing cords with points. Operation of these pieces of accessory equipment is based on the theory of "resistance heating" which simply means that the resistance of stainless steel to the flow of electric current is such that heat is generated in the wire when current is passed through it. To anneal a piece of wire, place it between the arms of the annealing fork (as in Fig. 1) and turn on the current by depressing the foot pedal. Should it be desired to anneal more of the wire than that portion between the arms, simply withdraw the wire slowly through the arms, making sure to maintain contact with each arm. Care must be exercised as sufficient heat can be generated to burn the wire in two. Use of the annealing points is described under Lingual Arch Construction.

*How to Weld.*—The actual process of welding is quite simple, convenient, and timesaving. The process itself, of course, precludes any butt joints, and all joints must be lapped. This applies, of course, to anterior and posterior bands, any of their attachments, and even spring construction. Welded joints, though, of course, considerably better and stronger, can be likened, for purposes of explanation, to riveted joints, each weld being a minute rivet. With this in mind, it is easy to see that one weld will not hold and can be very easily twisted off, whereas a series of welds, properly placed, are almost impossible to break loose. This analogy explains the necessity for several welds at the seam when constructing any type of band and the application of any of its attach-

ments. It also explains very clearly why it is impossible to weld two wires together without some form of mechanical retention, such as wrapping or soldering.

Molar bands are constructed by using a simple welded lap joint. Though anterior bands can be similarly made, the following technique is simpler, considerably faster, and probably gives a better fitting band. The material is fitted around the tooth and pinched on the lingual surface with anterior band-forming pliers. A series of welds is then made through the pinched material, as close to the band as possible, the excess material cut off and folded over, and welded along its edge to the band.

The attachment of all brackets and tubes is facilitated by welding flanges which are part of the attachment, extending from it in such a manner that welding is easily accomplished. One of the main advantages of spot-welded construction is that an attachment may be welded with one spot weld through one of the flanges and then checked for alignment, either by visual observation or by carrying it to the mouth. Any error of alignment is simply corrected by twisting the bracket on the weld as a pivot until it is correct, at which time the band and attachment are finish welded and accuracy of alignment is assured. Should the first point of welding place the attachment out of line, it is very simple to twist it off and replace it in a new position.

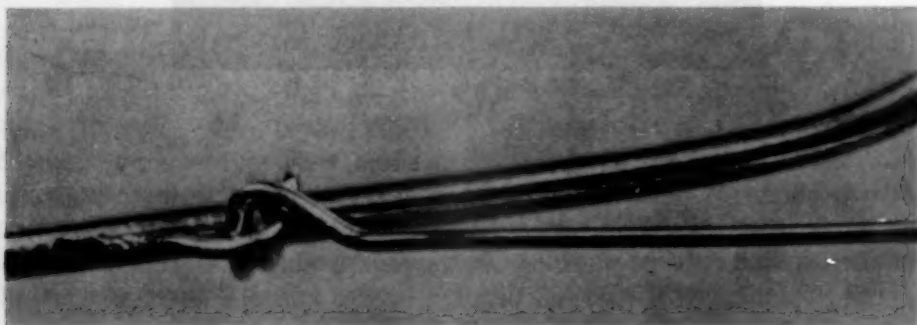


Fig. 2.

Auxiliary attachments of the operator's own design are simply constructed and easily welded, provided it is kept in mind that strong welded joints require flat surfaces, lapped, so that several welds may be made in the same plane. An example of this is an intermaxillary hook for the lower molar band, which I use a great deal. It is constructed by annealing a piece of 0.030 inch wire until it is dead soft, flattening one end by hammering, and attaching to the band by spot welding along the edge of the flat area. It is then bent to proper shape and cut off. However, hooks of this type, already flattened and scored for breaking off, and furnished in strips, may now be purchased from the manufacturer.

The welded auxiliary spring, though probably not as popular as the soldered spring, is used by quite a number of orthodontists. Its attachment relies on a combination of mechanical fixation and spot welding. Its construction is as

follows: Using a piece of 0.015 inch or 0.016 inch auxiliary spring wire (heavier than 0.016 inch should not be used for welded springs), anneal for a distance of about one inch from the end. Place the spring wire and arch between the electrodes of the welder, and weld at one point, using a very low heat and two or three pulsations. This weld is made at the point that will allow about one to one and one-half turns of the annealed wire to be wrapped around the arch, the last one-half to one turn of wrapping being within the hardened portion of the wire. The annealed portion of the wire is then bent over the wrapping and welded to the arch, as shown in Fig. 2.

#### SOLDERING

Despite popular opinion to the contrary, soldering operations on chrome alloy are quite simple and easy, though their limitations are definite, and dependable techniques must be followed. The main drawback of joining pieces of chrome alloy together with solder is the fact that there is no fusion between the solder and the pieces to be joined, as there is in precious metal soldering with gold. The strength of the soldered joint with chrome alloy is entirely dependent upon the strictly mechanical adaptation of the solder to the chrome alloy, so, for this reason, flat pieces and butted wires do not lend themselves to strong joints. This type of joint, however, can be successfully made, and when great strength is not desired, is sometimes very useful. In the usual orthodontic practice employing chrome alloy, welding is depended upon for almost all fabrication problems, possibly with the exception of such things as finger springs and intermaxillary hooks.

In employing the soldering technique with chrome alloy there is one absolute must, that is, the employment of a proper flux and its correct use. This should be of the bifluorid type, should be used in a creamy to liquid condition, and should be applied generously. It is wise to warm the area to be fluxed so that the flux will adhere closely.

The type of solder used is dependent upon individual preference. There are several very low fusing solders made for use with chrome alloy; however, most of them discolor very badly in the mouth. Generally speaking, most men using chrome materials rely on the better types of gold solder. My preference is a gold solder of 0.490 fineness and 1330° F. fusion point in 28-gauge wire form as furnished by Williams Gold Company. This solder, used in conjunction with flux manufactured by the Rocky Mountain Metal Products Company, makes a joint of extreme strength, no more bulky than a precious metal joint, and does not discolor in the mouth. Though the melting point of this solder is rather close to the annealing temperature of chrome alloy, careful technique will prevent any chance of annealing the wire. The thermal conductivity of chrome alloy is so low that only the very point of the soldering operation is brought up to the melting temperature of the solder. This is quite advantageous, of course, because it further reduces the chance of accidentally annealing the wire. For this reason, a very small flame (about the size of a round toothpick one inch long) should be used, and the point of soldering held just to the side of the point of the blue flame so that heating can be very deli-

cately controlled. In view of this "pinpoint" soldering, it is wise to use a solder in the thinnest possible wire form so as not to withdraw heat up the length of the solder. The actual operation of soldering is carried out in the usual manner, that is, flux both wires, apply solder to the heavier wire, and then bring the smaller wire into the molten solder. Should a butt joint be desired, it will be necessary to flow solder on the end of both pieces and then bring them together in the flame. As stated previously, this type of joint cannot be used where there is any great amount of stress, as it does not form a strong union.

Another method of soldering, which at times is quite useful, is the employment of the old "jeweler's carbon point" technique. This technique takes advantage of the fact that passage of electric current through a carbon point creates extremely high temperatures at the tip of the carbon. This unique characteristic is employed to melt the solder with the carbon point so that it flows over the wires to be jointed without heating the wires themselves.

Actual manipulation is as follows: The annealing cords are placed either in their receptacles on the welder and number 5 heat is switched on, or, for higher heat, the cords are inserted in the holes behind the electrode receptacles in the welding posts and number 2 heat is used. One of the annealing points is unscrewed and replaced with the carbon tip. This tip must be sharp and clean. The wires are then either tack welded together or held firmly in apposition by some other means, flux is flowed over the joint to be soldered, and a small piece of solder is put in place. Contact is then made with the annealing tip as close to the joint as possible and the carbon tip placed on the piece of solder. Current is turned on by depressing the foot pedal and almost immediately the point of the carbon tip becomes so hot that it will melt the piece of solder. The current is then immediately turned off. This method of soldering is especially useful where the application of a flame is contraindicated.

Probably one of the most popular soldering techniques, and one which I have employed for about fourteen years, involves a combination of welding and soldering. I originally demonstrated this technique before the Southwestern Society of Orthodontists at its 1940 meeting, and had employed it for three or four years previous to that time.

The technique was originally adopted to overcome the difficulty (which many men were experiencing at that time) of wires sliding out of the enveloping solder, and although this difficulty is not prevalent today, the technique is still employed probably more generally than any other because of the many advantages it offers. The technique is quite simple and advantageous, and joints so made are neat, delicate, and absolutely trustworthy. The technique requires simply that the wires to be soldered first be tack welded with one weld, the area well fluxed, and solder flowed over the joint. This type of union has the advantage in that the single weld acts as a rivet through the two wires, preventing either one from sliding through the enveloping solder, and the solder prevents the weld from being twisted loose. In the thirteen or fourteen years that I have employed this technique, I have never seen a single joint come loose. In addition to the perfection of the joint as such, the technique also presents other advantages. It is possible, for instance, to tack weld a wire in place and

then check its position and alignment before completing the soldering operation. This is quite useful, for instance, in soldering a labial section to a Hawley retainer. One end of the labial section is tacked to the loop, carried to the mouth and properly aligned, and then soldered in place. The Hawley is inserted in the mouth and the labial section bent to shape and cut off. It is then tack welded at its approximate position, is reinserted in the mouth to check alignment, and, should necessity require it, the tack weld is twisted loose and replaced in the proper position. After it is fitted exactly as the operator wants it, solder is then flowed over the joint to make a permanent union. Advantage may be taken of this technique in the same manner in the application of finger springs, loops, stops, or any other part that requires perfect placement and alignment, and that will be soldered to the appliance. When tacking the wires in position, it is wise to allow the auxiliary wire to project slightly past the base wire so that when soldering, the heat is carefully brought up this projection to the point of soldering. In this manner, any danger of overheating is obviated. After soldering, this projection is stoned off and smoothed (Fig. 3).

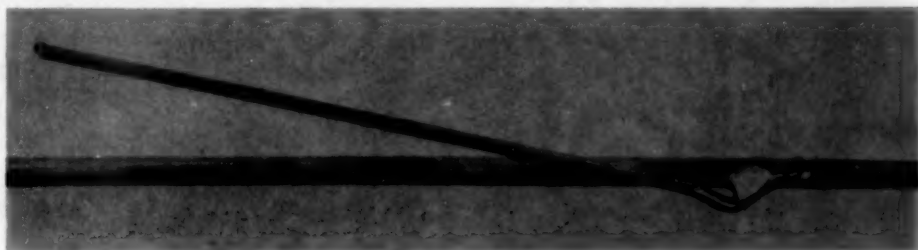


Fig. 3.

#### MOLAR BAND CONSTRUCTION

Seamless molar bands that are spun to the anatomical form of the tooth are available in sizes to fit any molar, either upper or lower, for those who desire to fit the bands in the mouth. They are fitted as any other ready-made band would be fitted, with the exception that they should be stretched to take advantage of the extreme hardness and tensile strength that is acquired by cold working. The simplest method is to select a band that is slightly smaller than the tooth to be fitted, and, with band stretchers, stretch it almost to size and then force it onto the tooth with the Eby band driver, or other type of instrument that will exert the necessary pressure. In this way, the band is made to fit the tooth perfectly, and in the process is hardened so that it is quite stiff and springy.

Molar bands may be made indirect on stone or other models in the same manner that precious metal ones are made, with the exception that the joint of the band is lapped about a millimeter and welded instead of soldered and the band is made slightly smaller than the model and is stretched with stretchers to proper size. However, probably the best method and one which takes full advantage of all of the possibilities of the material is as follows: A metal die is made of the tooth upon which the band is to be constructed, and the free

margin of the gum is ground off with rough sandpaper discs. A strip of band material is shaped around this die at the approximate position that the band will occupy and the material cut approximately one-half inch longer on each end so that stretching pliers may be efficiently applied. The seam of the band should be on the mesiobuccal corner and the band stretching pliers applied in such a manner that the material is actually stretched to conform to the size and shape of the tooth. Also, at this state, the material has been hardened considerably due to the stretching around the die. The material is now cut right at the pinch mark on one side and about a millimeter longer on the other side, lapped to the pinch mark, and welded securely. The band is now carried to the die and will be found to be slightly small at the gingival area, and will have to be worked very carefully onto the die by use of a pointed instrument between the die metal and the gingival border of the band. Using the edge of a small flat piece of steel and with light taps from a small hammer, the band is driven into position. This further stretching hardens the material additionally, and conforms it to the shape of the die. The occlusal edge is burnished closely to the die and is worked carefully into all grooves and fissures. Upon removal, one will find that he has a band which not only fits the tooth extremely accurately, but also is very, very hard, to the extent that it feels almost like a casting. I prefer to place the lingual tube at this time, though others do not put it on until the band is ready to wax into the impression. Trimming and contouring the gingival edge is completed at the chair. Seating the bands in the mouth, impression taking, waxing of the band, and pouring the work model are completed in the usual manner. After the lingual arch is constructed, the bands are removed from the model by warming slightly and all wax removed by scraping and swabbing with carbon tetrachloride. Hooks, buccal tubes, or any other form of buccal attachment are now welded into place. Lining up of buccal tubes, either directly in the mouth or on the model, is quite easy and time-saving. The tube is tacked (that is, welded at one point only) to the band and then seated on the model or in the mouth. It is a simple matter then to rotate this tube, either up or down, so that it lies in the proper plane. Should the tube turn too far out or in, it is twisted off and replaced so as to correct this inaccuracy. After being properly lined up, the band and tube are removed from the model or mouth, and welding is completed by placing three welds in each flange. Any rough spots are smoothed off and the whole is polished in the electrochemical polisher.

#### LINGUAL ARCHES

Every once in a while, one hears the opinion expressed that the lack of accurate lingual arch attachment has slowed the acceptance of chrome alloy in their practice. During the earlier "pioneer days" this opinion was probably justified, as quite often numerous and unique procedures were necessary to stabilize the lingual arch rigidly. This is not true today, and has not been true for many years. There are on the market today several lingual tube and post arrangements which are absolutely satisfactory and extremely accurate. Two of the most generally used are shown in Fig. 4. At the top is shown the tubes,

welded on lower molar bands, and at the bottom is shown the tubes and posts cross-sectioned by actual grinding, and photographed at considerable enlargement to show the accuracy of fit.

The tube on the right is used as is any other lingual tube; the one on the left, however, is made slightly undersized so that a standard post may be inserted before welding to the band, thereby drawing the material around the post and forming an extremely accurate attachment. This tube is formed of rather heavy material, and in conjunction with the natural toughness of chrome alloy, there is, for all practical purposes, no danger of stretch or wear whatsoever.

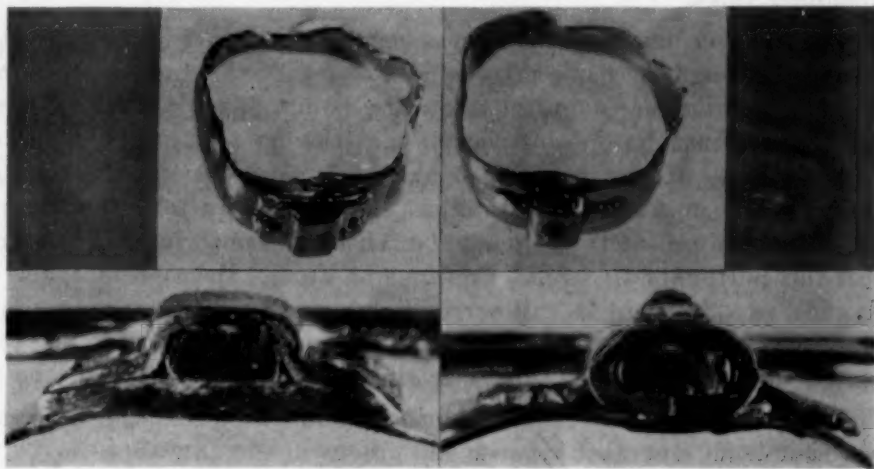


Fig. 4.

Prefabricated lingual arches with ready-formed posts are made from one piece of wire, and may be purchased in various lengths to fit any patient. During manufacture the posts are bent from the wire and then placed in a die where they are stamped under extreme pressure to form a perfectly fitting, absolutely accurate post. The same post can be made in the orthodontist's office if he cares to go to the trouble and expense of making a die. Although this die, for individual application, is quite expensive, still, with proper care and use, it will last for many, many years. On the other hand, prefabricated arches are quite economical and many hundreds can be bought for the cost of a single die.

Construction of the lingual arch and posts is as follows: It is presumed that molar bands have been fitted, impressions taken, and models run with the bands in position. A piece of 0.036 inch wire is selected and a very minute point is annealed completely, about one inch from the end. The wire is then folded upon itself at this annealed point, the *U* thus formed is squeezed tightly together with a pair of heavy Ellis post-forming pliers, and both ends are bent down at right angles to the post thus formed. The post is then laid in the die, with the side that will be next to the tooth surface facing upward. The flat plunger is dropped into place in the die machine and is hit one hard blow with a heavy hammer, to form the post to the shape of the die. It is then removed, inserted in the lingual tube on the model and the arch shaped as desired around

to the lingual tube on the opposite side. The position of this tube is then marked on the wire with a pencil mark, at the mesial edge of the tube opening. The wire is removed from the model and a minute portion annealed at the point which will later be the bottom of the post (approximately 4 mm. past the pencil mark). The wire is again folded on itself at this point, inserted in the Ellis post formers, and both ends of the wire bent at right angles to the post, care being taken to see that the post is turned gingivally.

This post is now inserted in the die machine and stamped as was the first one. The arch is carried back to the model and both posts inserted in their corresponding tubes.

Any tension remaining in the arch is very easily removed by a careful heat treatment. Although the flame may be used to pacify the arch, it is much better, cleaner, and simpler to use the annealing points of the welder. Place one annealing point immediately anterior to the post on one side and the other point about three-quarters of an inch anteriorly, and depress the foot pedal until the wire becomes dark red. Cut off the current by releasing the pedal, move the first point about three-quarters of an inch anteriorly of the other one, and heat this portion of the arch. Continue on around the arch until the other post is reached. If there is still some slight tension in the wire, repeat the process of pacification. Care must be exercised that the wire does not become overheated (bright red), as this will anneal the wire and ruin the arch.

The arch is now removed from the model, and both ends posteriorly to the post are completely annealed between the prongs of the annealing fork. (This is for the dead soft lock. Should a spring lock be desired, omit this annealing.) These ends are now placed in the reducing acid of the polisher and the polisher turned on, thereby reducing the diameter of the locks to that desired. The locks are then shaped and the whole arch is polished in the polishing acid and is ready for insertion in the mouth.

Application of prefabricated lingual arches follows the same technique outlined, except, of course, for construction of the posts. Simply measure around the arch from one tube to the other, and select the proper sized prefabricated arch to fit.

#### POLISHING

Of all the numerous advantageous characteristics of chrome alloy, probably the most appreciated is its resistance to corrosion and its ability to take a high lustre. This corrosion resistance of all of the stainless steels is believed to be due to the presence of a very thin continuous transparent film of oxide which forms naturally on the surface when exposed to the atmosphere, and which, because of its continuity, prevents further attack on the metal underneath. In view of the fact that this oxide film is formed naturally, it presupposes that the film is self-healing. In other words, should a break occur in the film, it will immediately heal itself by the natural reforming of this oxide coating. The formation of this film may be hastened, or it may be produced artificially, by a strong oxidizing agent, such as nitric acid, which does not attack the metal. The artificial formation of this oxide film is known as "passivation."<sup>18</sup>

In view of the fact that passivation by nitric acid involves considerable time (i.e., fifteen to twenty minutes) and the use of hazardous solutions, the technique is not practical in the orthodontist's office. However, a much-improved and more efficient technique, that combines both polishing and passivation, is that known as electropolishing. It is essentially an electrolytic process, being practically the opposite of electroplating. In other words, metal is removed from the surface of the stainless steel rather than being added, thereby producing a high polish and at the same time, passivation. The solutions used are nonhazardous and nearly odorless, and only low electric voltages are required.

Although this process is essentially an industrial process, and the usual equipment for it is quite large and expensive, there is a unit manufactured especially for orthodontic purposes. In use, the appliance or part to be polished is clipped in the alligator clip of the dipping arm, the arm placed in the central post between the two small cups, and the material submerged in the solution of one of the cups. The time switch is then turned on, thereby effecting current flow, and is left on until the part is polished. It is then removed and rinsed in water, and is ready for insertion in the mouth.

Although the machine is plugged into ordinary 110 volt line, the transformer reduces this voltage to about 12 to 13 volts. The amperage requirements vary with the type of solution used and the size of the part being polished, a small anterior band in the polishing solution requiring probably about one-half ampere, whereas a lingual arch will probably require four or five amperes.

The machine is also capable (by the use of proper solution) of reducing the size of wires and other pieces that may be desired. This is accomplished in the same manner that polishing is accomplished, except that a different solution is used and usually more time is required. The most efficient use of the machine is made by placing the polishing solution in one cup and the reducing solution in the other.

The reducing solution is ordinary orthophosphoric acid (85 per cent syrupy), 100 parts, and water, 15 parts. The polishing solution is made up of phosphoric acid (85 per cent syrupy), 100 parts, polyethylene glycol "600," 40 parts, and water, 15 parts. The action of these solutions is almost identical; however, the intensity of the action shows great variance between them. For instance, a piece of band material, 0.006 inch thick, will be reduced by about 0.0018 inch in thickness when placed in the reducing solution for one minute, whereas a similar piece of material placed in the polishing solution will be reduced only 0.0002 inch in thickness in one minute. Since the average time requirement for polishing an average orthodontic appliance, or any part, is only about twenty to thirty seconds, it can be seen immediately that any de-plating is so minute as to be entirely negligible. It should also be noted that once the appliance has been polished, it will never again require repolishing, as the oxide film coating is permanent and self-healing.

The only attention requirement of the machine is the maintenance of the proper water content of the solutions. In dry climates, and when the machine is used a great deal, water will be lost by evaporation. On the other hand, in

areas where the atmosphere is humid, the solutions will pick up excess water. Probably the simplest method of checking these solutions is by running a test piece every few days, keeping in mind that a very low water content will produce etched areas on the article, whereas a very high water content will give a slightly dull, smooth finish. A much more accurate method of maintaining the proper water content is by testing the solutions about once a week with an accurate hydrometer. Specific gravity readings should be approximately 1.504 for the polishing acid and 1.588 for the reducing acid. Keeping the solutions covered when not in use very materially minimizes any change. Wide latitude is permissible in the upper limit of water content; however, higher water content increases the intensity of the action and, consequently, the reduction of the material.

One of the most useful applications of the reducing solution is in reducing the diameter of the wire that is to become the lock on the finished lingual arch, an 0.036 inch wire being reduced to 0.025 inch in approximately two and one-half minutes. By the same procedure, wires may be reduced minute amounts to make loose fits in tubes where desired. In fact, this characteristic of uniform reduction of wires may be applied in any number of instances.

#### CONCLUSION

Adoption of the technique outlined herein will assure the user of simple, expedient application of chrome alloy in orthodontic appliance construction, with the assurance that all fabrications are neat, strong, and durable, and will, thereby, permit the use of this alloy that shows so many definite advantages over other orthodontic materials.

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### **Announcement to Future Essayists**

**A**T THE annual session of the American Association of Orthodontists in Louisville the following recommendations of the Publication and Editorial Board were adopted and are now official:

1. That many valuable articles are lost for publication because they were not prepared for such.
2. Authors expecting to have published, without expense, a profusion of illustrations impose a difficult task upon the editorial staff.
3. That the A.A.O. should adopt official instructions for essayists, including all constituent societies, as to the manner in which their manuscripts should be prepared for publication first and for presentation second.

The contract between the American Association of Orthodontists and the C. V. Mosby Company includes a stipulated sum to be spent for the illustrations of acceptable articles for publication. Any excesses of this budget must be paid out of the treasury of the A.A.O. and may become dangerously expensive.

Accordingly the A.A.O. passed a resolution in 1949 limiting the cost of illustrating any one article appearing in the JOURNAL. In the exercise of these instructions, the Editorial Staff of the JOURNAL has been most lenient and considerate, but the budget must be held within its limit. Excess costs of illustrations may be paid by the authors or other outside sources, if desired.

Avoid delay in the publication of your essay by limiting illustrations.

GEORGE R. MOORE,

Secretary-Treasurer, A.A.O.

S. J. KLOEHN, Chairman,

Publication and Editorial Board, A.A.O.

## Reports

### REPORT OF THE CONVENTION PLANNING COMMITTEE, AMERICAN ASSOCIATION OF ORTHODONTISTS, 1951

**F**ORTY-SIX annual meetings of the American Association of Orthodontists have been held since the year 1901, the year our association was organized. The first meeting convened in St. Louis, Mo., and since that memorable event, the City of St. Louis has been our host on four other occasions. Annual meetings have been held in various parts of the country, fifteen in the East, twenty in the Middle West, five in the West, four in the South, and our colleagues in Canada have been our hosts for two meetings in Toronto, Canada. Twelve meetings have been held in Chicago, five in New York City, five in St. Louis, two in Buffalo, two in Kansas City, two in Toronto, Canada, and one meeting in each of the following cities: Philadelphia, Detroit, Washington, D. C., Cleveland, Boston, Pittsburgh, Atlantic City, Columbus, Excelsior Springs, Nashville, Oklahoma City, New Orleans, Denver, San Francisco, Estes Park, Atlanta, Los Angeles, and Colorado Springs.

The board of directors, meeting in Chicago in 1950, discussed convention planning and facilities necessary to accommodate the increasing attendance at our annual meetings. President Joseph E. Johnson appointed the following members to serve on the Convention Planning Committee: Howard E. Strange, Chairman; Andrew F. Jackson, William Adams, George B. Crozat, Clare K. Madden, James W. Ford, Lowrie Porter, and James D. McCoy. Your committee was also directed to consider the possibility of holding a meeting in Europe in conjunction with the biennial session of the European Orthodontic Society. The present state of uncertainty and unrest and the very critical and serious international crisis preclude the possibility of arranging a joint meeting with our colleagues in other parts of the world. Therefore, a European assignment or joint meeting cannot be considered at this time.

Your Convention Planning Committee has not met to consider convention facilities; however, the chairman has assembled brochures, catalogues, and other information pertaining to accommodations and facilities for future meetings. These items have been placed in a folder for future reference and included are invitations from several convention planning committees and chambers of commerce in several cities that offer excellent accommodations for our annual meetings.

Our increasing membership in this association covers and includes a wide distribution throughout the entire country and Canada. Therefore, it would seem advisable to allocate meetings to various parts of the country, in cities that offer the best and most desirable accommodations with a consideration of accessibility for the greatest number of members.

Respectfully submitted,

HOWARD E. STRANGE, Chairman.

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Presented at the meeting of the American Association of Orthodontists, Louisville, Ky., April 23-26, 1951.

LIBRARIAN'S REPORT, AMERICAN ASSOCIATION OF  
ORTHODONTISTS, 1951\*

IN 1949 the American Association of Orthodontists placed bound copies of the proceedings of their meetings in the Library of the American Dental Association. Volumes not included are those of 1906, 1917, and 1918. It is hoped that these volumes may be obtained so that the bound set will be complete.

It was suggested in the report of the librarian for 1950 that inasmuch as the proceedings of the annual meetings were no longer printed in single volume form, the librarian might add a bound volume of the AMERICAN JOURNAL OF ORTHODONTICS to the library each year. It was also suggested that other volumes pertaining to orthodontics or allied subjects might be added.

Unless some plan for building up a library is thought advisable, I feel that the office of librarian is no longer necessary in the Association. It is my understanding that in the early years of the Association it was the librarian's duty to distribute volumes of the proceedings to the membership. After The C. V. Mosby Company took over the distribution of the proceedings, the librarian's only duty was to be custodian of several hundred extra volumes of the proceedings. These extra volumes, along with the bound edition, are now in the Library of the American Dental Association.

My suggestion would be to appoint a library committee to select the material for the American Association Library, if it is decided to build one.

Respectfully submitted,

RICHARD A. SMITH, Librarian,

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Presented at the meeting of the American Association of Orthodontists, Louisville, Ky., April 23-26, 1951.

\*The office of Librarian is now held by Dr. Charles R. Baker, of Evanston, Ill.

## Department of Orthodontic Abstracts and Reviews

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Edited by

DR. J. A. SALZMANN, NEW YORK CITY

All communications concerning further information about abstracted material and the acceptance of articles or books for consideration in this department should be addressed to Dr. J. A. Salzmänn, 654 Madison Avenue, New York City

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### Standards of Variation in the Eruption of the First Six Permanent Teeth:

By V. O. Hurme, D.M.D., *Child Development*, vol. 19, no. 4, December, 1948.

It became evident early in the course of this bibliographic study that presently available literature did not make the task of proper colligation easy. Not only were many of the best papers dealing with the time of eruption of the permanent teeth published in journals that are difficult of access, but the chief objective of the study made it absolutely necessary to review these papers in great detail. It was obvious that the standards derived would be of value only if they were based upon source material which met certain definite and reasonably exacting requirements.

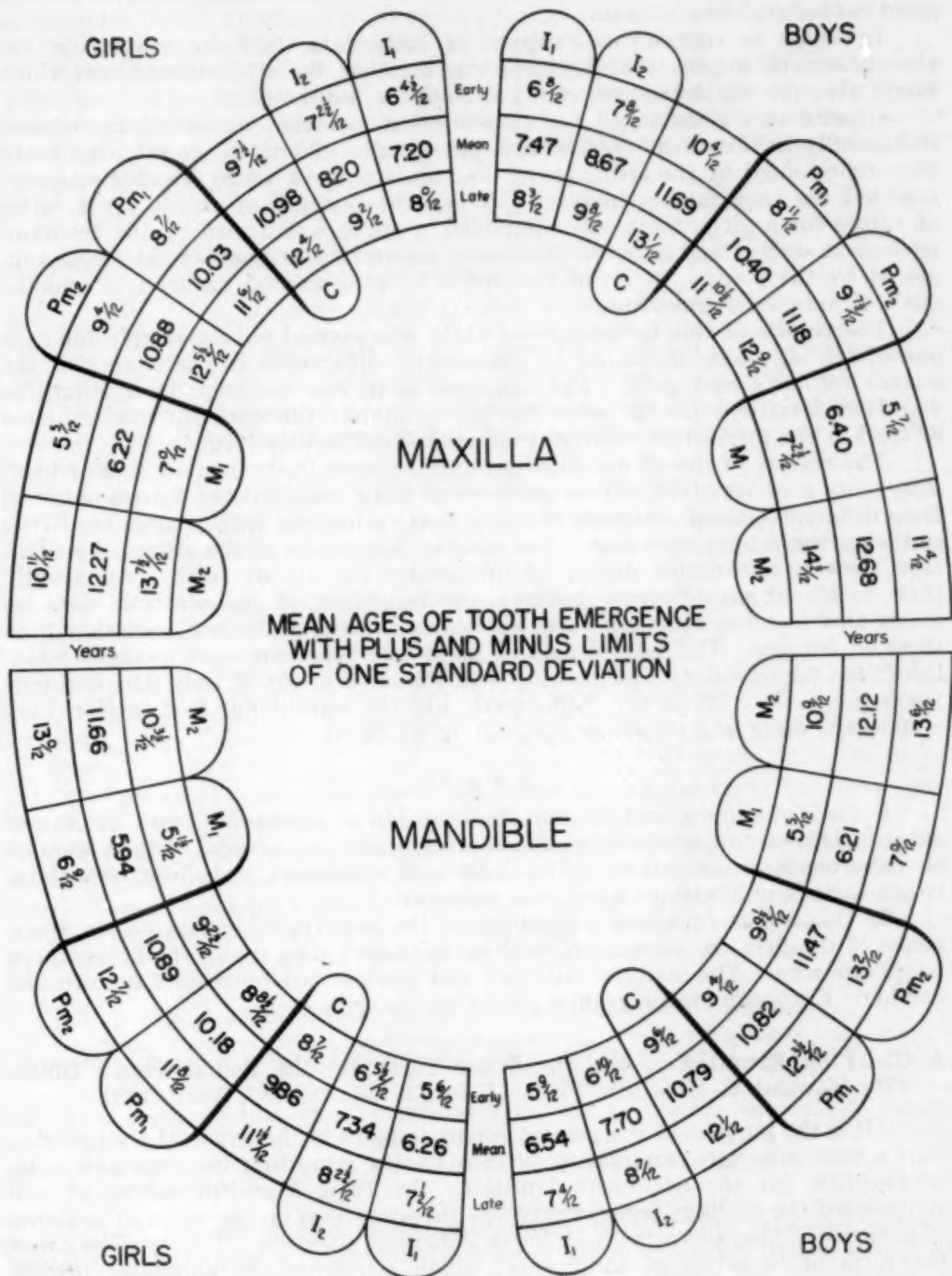
There were two main problems to be solved in attempting to summarize existing data on tooth emergence. The first of these had to do with the determination of the shapes of the frequency curves which give the cumulated percentages of erupted teeth at various age levels. The second important task was the selection of reports that could be used for calculating the mean and median ages of eruption of individual classes of teeth.

The first problem could be attacked only by determining what reports furnished figures that could be reduced to graphic form for describing chronologic variations in the eruption of individual teeth. The reports selected had to furnish data covering at least one-half of the age range during which a particular tooth crown is likely to make its debut into the external environment. The reports utilized for this purpose did not have to contain a definition of the term "eruption." It seemed safe to assume, after comparing several series of graphs representing data on teeth in various stages of eruption (i.e., graphs for teeth that are "just erupting," "in any stage of eruption," "fully erupted," etc.), that the shapes of the curves are not dependent to any appreciable degree upon the investigator's exact criteria of "eruption." This must not be taken to mean that careful studies in the future will not reveal statistical differences in the ranges of variation for different developmental stages of tooth emergence. The present study indicates only that if such differences do exist, they are of relatively small magnitude and of negligible importance in many biometric analyses. Therefore, the data were graphed on the presupposition that the average intervals between various stages of supragingival eruption are of equal magnitude at all age levels in a given group of children.

The second main problem had to do with the determination of the chronologic ages of tooth emergence. Before this problem could be attacked successfully, it was necessary to find out what reports dealt with tooth eruption in an unambiguous manner. The difficulties encountered here were threefold.

In the final computations only those reports could be utilized which contained reasonably clear indication of the meaning of the term "eruption" as used by the author.

The third difficulty encountered in tackling the problem of chronologic age was that relating to the sex differences in the ages of eruption. Even a cursory



Designed by V.O. Hurme, D.M.D.

Forsyth Dental Infirmary

Fig. 1.

survey of published data reveals the existence of much disagreement on this point between various authors.

In order to augment the supply of basic data used for computing the average sex differences, the literature was searched for other tabulations which would give the sex differences either directly or indirectly.

Graphs were constructed for all statistical material that could be reduced successfully to this form. Cumulated percentages of erupted or erupting teeth were represented by the ordinates of the points plotted, while the abscissae represented the time factors involved. When the plotting of points for a series of values for a given tooth was completed, a curve was drawn by the freehand method in such a way as to summarize as accurately as possible the trend suggested by the points. A trend line fitted by this method naturally "smooths out" all minor irregularities.

The results of this investigation, which was carried out separately for each one of the six teeth, indicated no noteworthy differences in the shapes of the curves for boys and girls. For this reason it was assumed, later, that the standard deviations for the sexes are approximately the same for a given class of teeth if the number of children examined is sufficiently large.

The results of the efforts to determine the most likely median ages of tooth emergence give one vivid picture of the surprising variability of figures obtained from different sources, although the data deal exclusively with Caucasians living in the northern temperate zone. Yet the standard errors of the averaged median ages show a remarkable degree of uniformity for all six teeth. Apparently there is almost no difference between the reliability of the available data on males and females, although those on males show slightly less variation than those on females. The median ages of tooth emergence are most securely established for the maxillary first incisor, with standard errors of only 0.04 and 0.05 years (i.e., +13 to 20 days). Some teeth, like the mandibular first incisor, have a standard error of 0.06 years (i.e., +21 to 23 days).

#### SUMMARY

1. Lack of summarized data on the eruption of permanent teeth has forced anthropologists and students of child development to contend with a number of disharmonious tabulations. The degrees of agreement and disagreement between various publications have been unknown.

2. This report furnishes a synthesis of the best available data on the emergence of the first six permanent teeth in boys and girls living in the northern temperate zone. The material analyzed and summarized represents western and northern European ethnic groups almost exclusively.

#### **A Chart on Eruption of the Deciduous Teeth for the Pediatrician's Office:** By Howard V. Meredith, Ph.D., *J. Pediat.* 38: 482-483, April, 1951.

"It is the purpose of the present report to place in the hands of the pediatrician a more adequate compilation of information regarding the time and order of eruption for the deciduous dentition. In 1946, Meredith assembled and synthesized the findings from twenty-two investigations on the age and sequence of eruption of deciduous teeth in North American children. This synthesis took the form of 'a series of statements' which attempted to 'epitomize present knowledge of the problem.'

"Chart I has been constructed from my 1946 integration of North American research materials on deciduous eruption. The objective in construction was to arrange in a form convenient for clinical reference, as many of the practically useful composite results as could be displayed on one page.

"It will be seen that the chart is captioned: Age and order of eruption for the deciduous dentition in North American white and Negro children. While

the available materials on North American Negro children are not as plentiful as those for North American white children, it appears that the two racial groups do not differ appreciably in eruption of the deciduous teeth.

"One frequently reads or hears statements similar to the following: 'In girls, teeth erupt earlier than in boys.' With particular reference to the deciduous dentition, such statements are incorrect. Investigative evidence shows conclusively that the teeth of the deciduous complement 'tend to erupt earlier in males than in females.'

## CHART I

## AGE AND ORDER OF ERUPTION FOR THE DECIDUOUS DENTITION IN NORTH AMERICAN WHITE AND NEGRO CHILDREN

*Age of Eruption of the First Deciduous Tooth\**

Number of Subjects	Mean Postnatal Age	Zone for 98 per cent	Range
1,095	7.5 mo.†	4 to 12 mo.	0‡ to 16 mo.

\*For about 95 per cent of infants the first tooth to erupt is a lower first incisor; occasionally, eruption begins with an upper first incisor, an upper second incisor, or a deciduous first molar.

†At age 6 months only one infant in three has any erupted teeth.

‡In rare instances, eruption of the deciduous dentition commences prior to birth. (For data on this problem, see Massler, M., and Savara, B. S.: J. PEDIAT. 36: 349, 1950.)

*Number of Erupted Deciduous Teeth at Selected Ages§*

Postnatal Age	Number of Subjects	Mean Number of Teeth	Zones for:		Range
			50 per cent	98 per cent	
9 mo.	670	3	2 to 5	0 to 8	0 to 12
12 mo.	700	6	4 to 8	1 to 11	0 to 20
18 mo.	500	13	10 to 14	6 to 18	4 to 20
24 mo.	510	17	15 to 18	10 to 19	8 to 20

§The process of deciduous eruption is timed about two weeks earlier in the average male than in the average female.

||The characteristic eruption sequence for the deciduous dentition is lower first incisors, upper first incisors, upper second incisors, lower second incisors, first molars (upper and lower), canines (upper and lower), lower second molars, upper second molars. Numerous individual variations occur, e.g., the third tooth to erupt is an upper second incisor in about 20 per cent of infants and a lower second incisor in about 5 per cent of infants.

*Age at Which Eruption of the Deciduous Dentition is Completed¶*

Number of Subjects	Mean Postnatal Age	Zone for 98 per cent	Range
226	28 mo.	18 to 36 mo.	10 to 38 mo.

¶The amount of time taken by different individuals in erupting the deciduous complement varies from less than nine months to thirty-five months; for over 90 per cent of children all twenty teeth erupt within time spans of eighteen to thirty months.

"Chart I treats the deciduous dentition exclusively. Pediatricians desiring similarly comprehensive information for the eruption of the permanent dentition are referred to the excellent recent work of Dr. V. O. Hurme."

"1. Hurme, V. O.: Ranges of Normalcy in the Eruption of Permanent Teeth, J. Dent. Child. 16: 11, 1949.

"2. Meredith, Howard V.: Order and Age of Eruption for the Deciduous Dentition, J. Dent. Research 25: 43, 1946."

## News and Notes

### The 1952 Meeting of the American Association of Orthodontists

The 1952 meeting of the American Association of Orthodontists will be held at the Jefferson Hotel, St. Louis, Mo., April 21 to April 24.

The chairman of the Local Arrangements Committee is Leo M. Shanley, 7800 Maryland Ave. The following local committees have been named to make the arrangements for the meeting:

#### *Local Arrangements*

Leo M. Shanley, Chairman	7800 Maryland Ave.	St. Louis, Mo.
E. V. Holestine, Treasurer	8015 Maryland Ave.	St. Louis, Mo.
Otto W. Brandhorst	4952 Maryland Ave.	St. Louis, Mo.
George H. Herbert	7002 Pershing Ave.	St. Louis, Mo.
Benno E. Lischer	313 N. Rock Hill Road	Webster Groves, Mo.
Albert C. Mogler	462 N. Taylor Ave.	St. Louis, Mo.
H. C. Pollock	8015 Maryland Ave.	St. Louis, Mo.
Frank C. Rodgers	Missouri Theatre Bldg.	St. Louis, Mo.
Henry F. Westhoff	Missouri Theatre Bldg.	St. Louis, Mo.
Joseph H. Williams	3722 Washington Blvd.	St. Louis, Mo.

#### *Stag Dinner*

Joseph H. Williams, Chairman	3722 Washington Blvd.	St. Louis, Mo.
Robert E. Bedell	1504 S. Grand Ave.	St. Louis, Mo.
Carl L. Rister	University Club Bldg.	St. Louis, Mo.
George Herbert	7002 Pershing Ave.	St. Louis, Mo.

#### *Ladies' Entertainment*

Earl C. Bean, Chairman	120 N. Forsythe Blvd.	St. Louis, Mo.
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#### *Co-Chairmen*

Mrs. B. G. deVries	40 Fair Oaks	St. Louis, Mo.
Mrs. H. C. Pollock	160 S. Gore Ave.	Webster Groves, Mo.
Mrs. Otto W. Brandhorst	24 S. Gore Ave.	Webster Groves, Mo.
Mrs. Joseph H. Williams	5 Glen Forest	St. Louis, Mo.
Mrs. Leo M. Shanley		

#### *Press*

H. F. Westhoff, Chairman	Missouri Theatre Bldg.	St. Louis, Mo.
H. C. Pollock	8015 Maryland Ave.	St. Louis, Mo.

#### *Banquet and Luncheons*

Virgil A. Kimmey, Chairman	3722 Washington Blvd.	St. Louis, Mo.
Robert E. Hennessy	8013 Maryland Ave.	St. Louis, Mo.
Robert C. Byrne	2602 S. Grand Ave.	St. Louis, Mo.

#### *Clinics*

Otto W. Brandhorst, Chairman	4952 Maryland Ave.	St. Louis, Mo.
Virgil A. Kimmey	3722 Washington Blvd.	St. Louis, Mo.
J. E. Rook	6651 Enright Ave.	St. Louis, Mo.

#### *Registration*

George Moore, Chairman	Box 8	Ann Arbor, Mich.
John Byrne, Co-Chairman	2602 S. Grand Ave.	St. Louis, Mo.

#### *Commercial Exhibits*

Earl E. Shepard, Chairman	4500 Olive St.	St. Louis, Mo.
William S. Brandhorst	4952 Maryland Ave.	St. Louis, Mo.
Fred Fabric	4559 Scott Ave.	St. Louis, Mo.

*Hosts*

Leo B. Lundergan, Chairman	4500 Olive St.	St. Louis, Mo.
Robert M. Courtney	University Club Bldg.	St. Louis, Mo.
Kenneth C. Marshall	35 N. Central	St. Louis, Mo.
Quentin M. Ringenberg	3722 Washington Blvd.	St. Louis, Mo.

*Property*

A. C. Mogler, Chairman	462 N. Taylor	St. Louis, Mo.
Paul E. Spoeneman	16 Hampton Village Plaza	St. Louis, Mo.
E. W. Hodgson	Missouri Theatre Bldg.	St. Louis, Mo.

*Reception*

H. C. Pollock, Chairman	8015 Maryland Ave.	St. Louis, Mo.
Benno Lischer	313 N. Rock Hill Road	Webster Groves, Mo.
Frank C. Rodgers	Missouri Theatre Bldg.	St. Louis, Mo.
Joseph Williams	3722 Washington Blvd.	St. Louis, Mo.
Otto W. Brandhorst	4952 Maryland Ave.	St. Louis, Mo.

*Hotel Reservations*

J. E. Rook, Chairman	6651 Enright	St. Louis, Mo.
H. C. Pollock, Jr.	8015 Maryland Ave.	St. Louis, Mo.

*Information*

George Herbert, Chairman	7002 Pershing Ave.	St. Louis, Mo.
Clarence R. Geier	3417 Meramec Ave.	St. Louis, Mo.
Everett W. Bedell	1504 S. Grand	St. Louis, Mo.

**American Board of Orthodontics**

The next meeting of the American Board of Orthodontics will be held at the Hotel Jefferson, St. Louis, Mo., April 16 to April 20, 1952. Orthodontists who desire to be certified by the Board may obtain application blanks from the Secretary, Dr. C. Edward Martinek, 661 Fisher Bldg., Detroit 2, Mich. To be considered at the St. Louis meeting, all applications must be filed before March 1, 1952.

**Great Lakes Society of Orthodontists**

The Twenty-second Annual Meeting of the Great Lakes Society of Orthodontists will be held Nov. 5, 6, and 7, 1951, at the Statler Hotel, Cleveland, Ohio.

**Northeastern Society of Orthodontists**

The next meeting of the Northeastern Society of Orthodontists will be held at the Hotel Warwick, Philadelphia, Pa., on Nov. 12 and 13, 1951.

**The New Orleans Dental Conference**

The Fourth Annual New Orleans Dental Conference will be held at the Roosevelt Hotel, New Orleans, Nov. 11, 12, 13, and 14, 1951.

Dr. M. R. Matta, Secretary,  
629 Maison Blanche Bldg.,  
New Orleans, La.

**Academy of Oral Pathology**

The Academy of Oral Pathology will hold its sixth annual meeting at the Stevens Hotel, Chicago, on Feb. 3, 1952.

The program will include discussions on the physiology of bone, bone behavior, and periodontal disease, dermatological diseases affecting the oral cavity, studies of oral carcinomas, dental anomalies, and gingival enlargement.

All interested dentists are welcome to attend the meetings.

Hamilton B. G. Robinson,  
Chairman, Publicity Committee.

### Rocky Mountain Society of Orthodontists

The Rocky Mountain Society of Orthodontists will hold their annual fall meeting on November 5 and 6 in the Study Club Rooms of the Denver Dental Association at Denver General Hospital in Denver, Colo.

The program will include:

Andrew Francis Jackson, D.D.S., F.D.S.R.C.S.(Eng.), F.I.C.D., Philadelphia, Pa.

John T. Jacobs, M.D., Orthopedic Surgeon; Instructor, University of Colorado, College of Medicine, Denver, Colo.

A Motion Picture Study of Childhood Habits Which Affect Dental Occlusion and Facial Development. Courtesy of Kyrle W. Preis, D.D.S., F.A.C.D., Baltimore, Md.

Case reports by members.

Luncheon panel composed of Drs. Henry F. Hoffman, Wm. R. Humphrey, and J. Lyndon Carman, Moderator.

### Eighth Annual Dental Seminar

Two hundred dentists, including top dental-medical researchers, will be in attendance at the Eighth Annual Dental Seminar to be held at the Desert Inn, Palm Springs, Calif., Oct. 28 through Nov. 1, 1951.

Advance registrations, according to an announcement by Dr. Hermann Becks, seminar president, indicate a capacity turnout for the five-day study sessions.

A Parodontopathies Workshop will be a major feature of the professional gathering this year, with the entire attendance divided into special study groups devoted to various phases of the problem.

Included in the lecture-packed program, to be discussed and analyzed at the meeting, are the following important topics:

Practical physiological lung problems in the sedentary professional man.

Cancer of the oropharynx and respiratory system.

The role of infection in periodontal disease.

Etiological factors in periodontal disease.

Studies on the defense mechanisms of the mouth and mucous membranes.

Nutritional disturbances in childhood, with particular emphasis on the celiac syndrome and pancreatic insufficiency.

The clinical laboratory in a children's hospital.

The structure and properties of tooth surfaces as studied by optical and electron microscopy.

Electron microscopy of dental tissues, including enamel, dentine, cuticle, epithelial attachment, etc.

Protein deficiencies via soil deficiencies.

Some new concepts concerning the role of sugar in dental caries.

The putrefaction of proteins in relation to periodontal disease.

Seminar lecturers will participate in a round-table forum covering the application of the subjects studied to dental practice, which will conclude the 1951 sessions.

### International Academy of Oral Dynamics

The International Academy of Oral Dynamics (Bite-Correction) will meet on Sunday, October 14 at 2:00 P.M. at their headquarters, 5510 Sixteenth St., N.W., Washington, D. C. This academy was organized at the A.D.A. meeting at Atlantic City last year.

Anyone interested in learning more about this phase of dentistry should contact me at the address below, or Dr. Thomas H. Forde, at our headquarters.

Clinics and refresher courses will be presented.

JAMES J. GREEVES, D.D.S.,  
Publicity Chairman—President-Elect,  
1801 K Street, N.W.,  
Washington 6, D. C.

### European Orthodontic Society

In 1952 the Congress of the European Orthodontic Society will take place in Amsterdam, Holland, from July 14 to July 17.

These dates are chosen in view of the congress of the F.D.I. which starts on July 19, 1952, in London. We hope that many Americans who will attend the meeting of the F.D.I. will take the opportunity to come over to Amsterdam.

Further details can be obtained from:

Mr. J. A. C. Duyzings, President,  
Hamburgerstraat 19,  
Utrecht, Netherlands.

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### American Dental Association

The skyrocketing costs of Great Britain's health scheme are again forcing the British government to reduce that country's already lowered dental health standards, *The Journal of the American Dental Association* declared editorially recently.

Faced with increasing costs and an overwhelming public demand for dental services, the government is now proposing to use inadequately trained dental nurses to extract and fill children's teeth, the Journal asserted.

The editorial pointed out that instead of trying to raise the level of children's dental health which has grown steadily worse, the British health ministry is now proposing a mass repair program by partially trained personnel.

"The pattern of a national compulsory health insurance program never changes," the Journal continued.

"Preceded by extravagant political promises, the system imposes special taxes on the public for which the gullible expect, but rarely receive, special services.

"It imposes special regulations and restrictions on the practitioner which tend to lower the quality of service and the national standards of dental health.

"Lastly and inevitably, in order to cut costs and make good on their grandiose promises, the politicians further dilute the standards of service by injecting partially trained auxiliaries into the ranks of the profession.

"Britain apparently is determined to embark on a scheme of substandard service rather than to launch a program of dental research and prevention which would eventually reduce the prevalence of dental disease."

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The illegal making of artificial dentures by individuals unqualified and unlicensed to practice dentistry is a threat to the dental health of the public, a dental educator declared recently in *The Journal of the American Dental Association*.

Dr. Walter Henry Wright, Dean of the New York University College of Dentistry, reported that the illicit practice was increasing in large cities and added:

"The dental profession can no longer maintain a complacent attitude toward the illegal making of complete dentures by technicians. Amid social changes, it is not improbable that such forms of low-grade dentistry might receive political sanction, unless dentists are intent on guarding the oral health of the public."

Calling for a more rigid enforcement of dental laws to protect the public's dental health, Dr. Wright pointed out that the making of dentures is dictated by the biologic requirement of each mouth, making it imperative that every procedure be under the control of the dentist to protect both the patient's dental health and general health.

"Design, support and occlusion (bite) are interrelated biomechanical requirements which cannot be delegated to the technician," he said.

## OFFICERS OF ORTHODONTIC SOCIETIES

The AMERICAN JOURNAL OF ORTHODONTICS is the official publication of the American Association of Orthodontists and the following component societies. The editorial board of the AMERICAN JOURNAL OF ORTHODONTICS is composed of a representative of each one of the component societies of the American Association of Orthodontists.

### American Association of Orthodontists

*President*, Bernard G. deVries - - - - - 705 Medical Arts Bldg., Minneapolis, Minn.  
*President-Elect*, Brooks Bell - - - - - 4150 Mockingbird Lane, Dallas, Texas  
*Vice-President*, Malcolm R. Chipman - - - 1251 Medical Dental Bldg., Spokane, Wash.  
*Secretary-Treasurer*, George R. Moore - - - - 919 Oakland Ave., Ann Arbor, Mich.

### Central Section of the American Association of Orthodontists

*President*, P. M. Dunn - - - - - Medical Arts Bldg., Minneapolis, Minn.  
*Secretary-Treasurer*, Earl E. Shepard - - - - - 4500 Olive St., St. Louis, Mo.

### Great Lakes Society of Orthodontists

*President*, Richard E. Barnes - - - - - 638 Keith Bldg., Cleveland, Ohio  
*Secretary-Treasurer*, Carl R. Anderson - - - - 402 Loraine Bldg., Grand Rapids, Mich.

### Northeastern Society of Orthodontists

*President*, Paul Hoffman - - - - - 1835 Eye St., N.W., Washington, D. C.  
*Secretary-Treasurer*, Oscar Jacobson - - - - - 35 W. 81st St., New York, N. Y.

### Pacific Coast Society of Orthodontists

*President*, Reuben L. Blake - - - - - 240 Stockton St., San Francisco, Calif.  
*Secretary-Treasurer*, Frederick T. West - - - - 760 Market St., San Francisco, Calif.

### Rocky Mountain Society of Orthodontists

*President*, Ernest T. Klein - - - - - 632 Republic Bldg., Denver, Colo.  
*Vice-President*, Curtis E. Burson - - - - - 1232 Republic Bldg., Denver, Colo.  
*Secretary-Treasurer*, Don V. Benkendorf - - - - 932 Metropolitan Bldg., Denver, Colo.

### Southern Society of Orthodontists

*President*, Walter T. McFall - - - - - Flatiron Bldg., Asheville, N. C.  
*Secretary-Treasurer*, Frank P. Bowyer - - - - - Medical Arts Bldg., Knoxville, Tenn.

### Southwestern Society of Orthodontists

*President*, Walter Lipscomb - - - - - Medical Arts Bldg., Houston, Texas  
*Secretary-Treasurer*, Marion A. Flesher - - - - Medical Arts Bldg., Oklahoma City, Okla.

### American Board of Orthodontics

*President*, Stephen C. Hopkins - - - - - 1746 K St., N. W., Washington, D. C.  
*Vice-President*, Leuman Waugh - - - - - 931 Fifth Ave., New York, N. Y.  
*Secretary*, C. Edward Martinek - - - - - 661 Fisher Bldg., Detroit, Mich.  
*Treasurer*, Reuben E. Olson - - - - - 712 Bitting Bldg., Wichita, Kan.  
*Director*, Raymond L. Webster - - - - - 133 Waterman St., Providence, R. I.  
*Director*, Ernest L. Johnson - - - - - 450 Sutter St., San Francisco, Calif.  
*Director*, Lowrie J. Porter - - - - - 41 East 57th St., New York, N. Y.